Progress of

AGRICULTURAL RESEARCH IN OHIO

1936-1937

Ohio Agricultural Experiment Station
Wooster, Ohio

BULLETIN 592 MAY, 1938

Fifty-sixth Annual Report

of the

Ohio Agricultural Experiment Station

For the Year ended June 30, 1937

Wooster, Ohio
Experiment Station Press
1938

Apple orchard in bloom at the Ohio Agricultural Experiment Station

HONORABLE LAWRENCE E. LAYBOURNE,
President of the Board of Control,
Ohio Agricultural Experiment Station.
My dear Sir:

I have the honor to present to the Board of Control for transmission to the Governor of Ohio, as required by law, the fifty-sixth annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1937.

EDMUND SECREST,
Director.

HONORABLE MARTIN L. DAVEY,
Governor of Ohio.
My dear Sir:

I have the honor to present to you the fifty-sixth annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1937.

Very truly yours,
LAWRENCE E. LAYBOURNE,
President, Board of Control.

OHIO AGRICULTURAL EXPERIMENT STATION

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N. L. ALTER, B. S., *Florist*
O. N. RILEY, *Foreman Wash. Co. Truck Farm*
HARRY OBENOUR, *Foreman Muck Crops Expt. Farm*

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ELZA MCCALL ..... Supt. Southeastern Expt. Farm, Carpenter
CECIL FRYMAN ..... Resident Foreman Hamilton Co. Expt. Farm, Mt. Healthy

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[1]In cooperation with College of Agriculture, Ohio State University.
[2]In cooperation with the U. S. Department of Agriculture.

INDEX TO DEPARTMENTS

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WEATHER

FIFTY-SIXTH ANNUAL REPORT
OF THE
OHIO AGRICULTURAL EXPERIMENT STATION

The past year has been significant in the annals of American agriculture. It marked the seventy-fifth anniversary of the passage by Congress of the Morrill Act, which by grants to the states encouraged the establishment of the Land Grant Colleges and laid the foundation for instruction in agricultural science.

The past year also witnessed the fiftieth anniversary of the Hatch Act, by which the Congress extended Federal aid to the states in the development of agricultural experiment stations for research in agriculture. During the half century, science has made substantial progress, and the application of discoveries through research has added wealth to the agricultural industry and has contributed to both rural and urban welfare far beyond our ability to appraise. Considering the modest beginning made necessary by lack of resources in funds and trained personnel, the state agricultural experiment stations have a record of achievement that justifies state pride in these institutions. Moreover, the consistent growth and expanded usefulness are dedicated in large measure to the foresightedness, integrity, and ability of the earlier leaders in station work.

The Ohio Station was established by an Act of the Legislature in 1882 which declares: "That for the benefit of practical and scientific agriculture, and for the development of the vast agricultural resources of the state, an Ohio Agricultural Experiment Station is established." It was the fifth of its kind to be established, and in the words of former Director Charles E. Thorne: "For many years it was itself an experiment for the work it was to perform was a new industry in the world, and it was necessary to first learn how to experiment."

The earlier experiments and projects were set up with particularized objectives and with intended practical application. In many cases they were to meet emergencies, to throw up quick defences against animal and plant diseases and pests. There were those to develop varieties of plants for particular conditions, the determination of specific economic problems, the feeding and management of livestock and dairy herds, and the major problems of maintaining soil fertility. The Station worker knew the farmer's problems and his close contact and sympathetic understanding are reflected in the support given the Institution.

The particularized objective in agricultural research has been extremely valuable and will continue to be necessary, but the field of science is open for exploration and more basic research is needed to supplement the many restricted fields of specific application. The Federal Bankhead-Jones Act of 1935, which allocates funds to state experiment stations, contemplates the need for foundation research to establish laws and principles. The importance of such basic research becomes obvious and we have come to appreciate that it can sometimes be more practical than short-cut research. The discovery of a simple truth may have wide application. At the beginning of the present century scientists determined that certain animal and plant diseases were caused by filterable viruses. This discovery resulted in the perfection of a

serum effective in the control of hog cholera, a disease the ravages of which formerly caused great losses in swine herds. It furnishes as well a basic knowledge for the solution of problems of many diseases in animals, plants, and human beings.

The discovery that resistance to disease is a genetic character, the factors for which may be inherited, ultimately may mean more than innumerable attacks on specific plant diseases.

Basic studies have led to exact knowledge of vitamins, which has solved many of the problems of livestock rations and human nutrition. It has influenced medical thought and practice, and has measurably changed the dietary habits of a large part of our population.

FEDERAL COOPERATION

Although Federal and state cooperation in projects has obtained for some time, coordination of effort directed toward a more effective and economical solution of our agricultural problems, as well as a more comprehensive program, is made possible by the Bankhead-Jones Act. The Act authorizes the establishment of regional Federal laboratories for specific research projects. Although the laboratories are maintained by the United States Department of Agriculture, the projects adopted are recommended by the experiment stations of the regions concerned, and they participate in the conduct of the investigations. Two such laboratories have been established in the North Central Region, of which Ohio is a part. One is for the investigation of the industrial uses of soybeans, and the other for research in swine breeding. The Ohio Station has representatives on the advisory councils of both laboratories.

A soft winter wheat laboratory has been equipped at the Ohio Station by the United States Department of Agriculture and cooperatively serves the soft wheat region east of the Mississippi River. The object of the investigations is to study the characteristics and determine the quality of soft winter wheat as used for different purposes, to devise methods for evaluating varieties, to study the effect of environment on soft wheat quality, and to provide for the characterization and evaluation of new varieties which, because of superior agronomic qualities, are released for commercial production.

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Dr. C. G. Williams, for 16 years Director of the Ohio Station, resigned effective June 30, 1937. Dr. Williams served this Institution as Agronomist from 1903 to 1925. He will retain connection with the Station as Director Emeritus and Consulting Agronomist.

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CHANGES IN PERSONNEL

The following appointments to the staff were made during the year:
Charlotte Ames, Editor, vice Emma Collins, resigned
Mary Hollopeter, Librarian, vice Margaret Gourley, resigned
E. B. Poling, Assistant in Rural Economics, vice John R. Suter, resigned
Oscar Brumley, Associate in Animal Industry
C. A. Woodhouse, Assistant in Animal Industry
Edmund Secrest, Director

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PUBLICATIONS

BIMONTHLY BULLETINS

	Year ended June 30, 1937		
	Number of pages	Edition printed	Total no. of pages
July-August, 1936	20	29,500	590,000
September-October, 1936	20	32,500	650,000
November-December, 1936	24	28,000	672,000
January-February, 1937	40	28,000	1,120,000
March-April, 1937	40	28,500	1,140,000
May-June, 1937	32	28,000	896,000

MONOGRAPH BULLETINS

No.	Title			
571	The influence of various factors upon the growth and quality of fine wool as obtained from Merino sheep	60	4,000	240,000
572	Stationary equipment for orchard spraying and the manufacture of home-made liquid lime-sulfur	28	3,500	98,000
573	The common storage	52	3,500	182,000
574	A study of cooperative milk marketing associations in four Ohio markets	64	3,500	224,000
575	Basal metabolism of older women	16	3,500	56,000
576	The influence of the stage of maturity on the chemical composition and the vitamin B (B_1) and G content of hays and pasture grasses	20	4,000	80,000
577	Ohio agricultural statistics, 1935	92	6,500	598,000
578	Soil management systems in a young Bartlett pear orchard	40	3,500	140,000
579	Fifty-fifth annual report	144	3,800	547,200
580	Cultural systems for the apple in Ohio	36	4,000	144,000
581	Peach production in Ohio	44	3,500	154,000
582	Population mobility in selected areas of rural Ohio, 1928-1935	56	3,500	196,000

SPECIAL CIRCULARS

49	The mineral needs of farm animals	8	5,000	40,000

MISCELLANEOUS CIRCULARS

10				152,400

REPRINTS

38	Monograph bulletins	3,820,000
8	Bimonthly bulletins	886,000

WEEKLY PRESS BULLETINS

52		240,000
	Total bulletin pages printed during the year	12,865,200
	Total number of names on the Station mailing list	31,946

JOURNAL ARTICLES

Agnew, C. Manning and H. D. Brown. 1937. Comparative tests of seed drills used in vegetable production. Am. Soc. Hort. Sci. 34: 554-558.

Bayfield, E. G. 1936. Report of the Subcommittee on Viscosity. Cereal Chem. 13: 773-788.

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Bushnell, John. 1937. Fertilizers in the subsoil for potatoes. Am. Potato Jour. 14: 78-81. Also published in Proc. Ohio Veg. Growers Assoc. 22: 67-69.

————. 1936. Fertilizer placement studies with potatoes in Ohio, season of 1936. Nat. Joint Com. on Fertilizer Application Proc. 12: 73-74.

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Conrey, G. W. 1937. Chemical characteristics as a factor in determination of class and use of land. Soil Sci. Soc. of Am. 1: 459-462.

Cutright, C. R. 1937. Effect of certain codling moth spray schedules on other orchard insects. Jour. Ec. Ent. 30: 413-417.

————. 1937. Experiments in the control of orchard insects. Proc. of the 70th Ann. Meeting, Ohio State Hort. Soc. pp. 48-57.

————. 1937. Control of the rosy and green apple aphis. Proc. of the 70th Ann. Meeting, Ohio State Hort. Soc. pp. 166-171.

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Edgington, B. H. 1937. Titer fluctuations in agglutination tests for pullorum disease in hens. Poul. Sci. 16: 15-18.

————. 1936. A study of the effects of Brucella abortion in udderless cows. Jour. Agr. Res. 53: No. 3, 225-233.

Ellenwood, C. W. 1937. Origin of handling bruises in harvesting apples. Proc. 70th Ann. Meeting Ohio State Hort. Soc. pp. 36-44.

Gerlaugh, Paul. 1936. The use of varying quantities of a 45 percent protein supplement in rations for fattening calves. Record of Proc. of 29th Ann. Meeting Am. Soc. of Animal Production pp. 60-63.

Gourley, J. H. 1937. Color factor in fruits. Proc. 39th Ann. Meeting Maryland State Hort. Soc. pp. 61-63.

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————. 1936. A soil program for the orchard. Proc. Conn. Pomol. Soc.

Gui, Harry L. 1936. Progress of cabbage worm investigation at the Ohio Agr. Exp. Sta. Ohio Veg. Growers Assoc. Proc. 21st Ann. Meeting pp. 33-40.

Havis, Leon and J. H. Gourley. 1937. Soil organic matter and porosity of an orchard soil under different cultural systems. Soil Sci. 43: No. 6, 413-420.

————. 1937. Winter injury and drouth damage to stone fruits. Recommended varieties. Proc. Ohio State Hort. Soc. 70: 23-31.

————. 1937. The morphology and anatomy of the dahlia seedling. Am. Soc. Hort. Sci. 34: 592-594.

Hoffman, I. C. 1936. Recent advances in vegetable forcing. Veg. Growers Assoc. of Am. Ann. Rep. pp. 172-177.

————. 1937. The effect of spacing fall tomatoes on the yield, size, and grade of fruit. Ohio Veg. Growers Assoc. Proc. pp. 85-87.

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Krauss, W. E. 1937. The cow—mankind's foster mother. Am. Assoc. of Medical Milk Commissions and Certified Milk Prod. Assoc. of Am. Symposium on Nutrition pp. 8-12.

————, R. M. Bethke, and R. G. Washburn. 1936. Factors affecting the activatability of milk with ultra-violet light. Jour. Dairy Sci. 12: 739-747.
Lamb, C. A. and Robert M. Salter. 1936. Response of wheat varieties to different fertility levels. Jour. Agr. Res. 53: 129-143.
————. 1937. The relation of awns to the productivity of Ohio wheats. Jour. Am. Soc. Agron. 29: 339-349.
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Lewis, I. P. 1937. Development in spraying practice. Proc. 70th Ann. Meeting Ohio State Hort. Soc. pp. 60-66.
Lively, C. E. 1937. Spatial and occupational changes of particular significance to the student of population mobility. Social Forces 15: 351-355.
McBride, C. G. Milk marketing problems. Jour. of Farm Econ. 19: No. 2, 494-496.
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Reed, C. O. 1937. Agricultural engineering and its public. Address as 1937 recipient of McCormick Medal. Agr. Eng. Jour. 18: No. 8.
Robison, W. L. 1936. Making cottonseed meal safe and efficient when fed as the only protein concentrate to pigs in dry lot. Record of Proc. of 29th Ann. Meeting Am. Soc. of Animal Production pp. 87-91.
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Silver, E. A. 1936. Storage of corn fodder or stover. Agr. Eng. Jour. Sept.
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———— and John Bushnell. 1937. Variations in nymphal populations of the potato leafhopper on different varieties of potatoes. Am. Potato Jour. 14: 242-245.
Tilford, Paul E. 1937. The effect of varying the copper-lime ratio in Bordeaux mixture on potato yields. Proc. Ohio Veg. Growers Assoc. 22nd Ann. Meeting pp. 57-60.
Wilson, J. D. and B. E. Livingston. 1937. Lag in water absorption by plants in water culture with respect to changes in wind. Plant Physiol. 12: 135-150.

THE STATION LIBRARY

The total number of bound volumes in the General Library and the seven departmental libraries was 15,663 on June 30, 1937. Figures are included in the following summary for the year since the last report:

Number of bound volumes in the Library	15,663
Books accessioned, July 1, 1936, to June 30, 1937	288
From bindery	214
New books	74
Scientific periodical subscriptions	94
Exchanges	147
Inter-library loans	141
Bulletins, foreign publications other than journals, and reprints	2,325

AGRONOMY

SWEET CLOVER EFFICIENT GREEN MANURE

Plowing down sweet clover for green manure in the spring following the year of seeding is an effective and economical method of increasing crop yields and building up soil nitrogen and humus on soils well supplied with lime. The 2-year corn, oats rotation, still too common in sections of western Ohio, is notably improved by seeding sweet clover in the oats and plowing it under for the corn. The common corn, oats, wheat, hay rotation often can be advantageously rearranged into a rotation of corn, oats, hay, wheat (sweet clover), with the sod land plowed for wheat and the wheat seeded to sweet clover to be plowed down the next spring for corn.

The effects of adding a sweet clover green manure crop to a corn, oats rotation in experiments at three locations are shown in Table 1. The increases in yield of the grain crops are especially large in the Paulding County test, probably because the improvements in tilth and drainage produced by the deep-rooted sweet clover crop are most beneficial on the heavy clay soil of this region.

TABLE 1.—Effect of Sweet Clover Green Manure in Corn, Oats Rotation

Location and soil type	Period	Average yields and increases per acre					
		Corn			Oats		
		No sweet clover	Sweet clover	Increase	No sweet clover	Sweet clover	Increase
	Yr.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Paulding County Experiment Farm Paulding clay	12	28.3	45.6	17.3	39.5	48.2	8.7
Northwestern Experiment Farm, Holgate, Henry County Brookston clay	5	49.7	62.7	13.0	49.2	51.7	2.5
Main Experiment Farm Wooster, Wayne County Canfield silt loam	8	44.9 42.7	55.4 66.1*	10.5 23.4*	32.9 32.8	34.4 37.6*	1.5 4.8*

*Straw and stover, averaging 2.6 tons, spread on sweet clover before plowing under.

A notable result in the Wooster experiment has been the increased yields produced by applying the straw and corn stover to the sweet clover sod just before plowing (bottom line, Table 1). The addition of these residues, averaging in amount 2.6 tons per acre, has increased the yield of corn 12.9 bushels and of oats 3.3 bushels compared with sweet clover alone. Since in another experiment of similar duration on the same soil, 3 tons of corn stover and wheat straw applied before spring-plowing a mixed meadow sod has increased the yield of corn only 3.2 bushels, it appears that there may be some special merit in combining such carbonaceous residues with a highly nitrogenous green manure like sweet clover. A plausible explanation is found in two well-known facts: (1) that green clover decomposes very quickly with so rapid a production of nitrates that a considerable portion may be leached out or carried to inaccessible depths before the growing crop can make use of them, and (2) that

in the decomposition of incorporated carbonaceous residues, such as straw and stover, the amounts of nitrogen contained are inadequate for the life processes of the microorganisms concerned; hence they are forced to compete with the growing crop for nitrates and other available mineral nutrients. When carbonaceous residues are combined with sweet clover, these effects probably tend to offset each other, and the excess nitrates produced by the decomposition of the sweet clover are probably used by the microorganisms decomposing the straw and stover to form microbial proteins. The latter might be expected to undergo gradual decomposition with the progressive formation of nitrates during the period of greatest need by the growing crop.

Although definite conclusions must await the completion of further tests of the foregoing method, the spreading of straw and corn stalks or stover on sweet clover before plowing under is suggested as a likely method for increasing the effectiveness both of the residues and the green manure. (Salter)

EFFECTS OF DELAYED APPLICATIONS OF COMPLETE FERTILIZERS ON CORN

Favorable results in 1936 from applying a complete fertilizer to drilled corn at the time of first cultivation led to an enlarged experiment in 1937 which included comparisons of increasing amounts of a 2-12-6 fertilizer applied to both checked and drilled corn at planting time, at the first or last cultivation, or at various combinations of these times. A standard make of planter equipped with an improved fertilizer depositor was used for planting and making the first fertilizer application. Delayed treatments were made with a hand-operated machine that drilled the fertilizer for both checked and drilled corn. Ohio W17 hybrid corn was planted in four random blocks. Data secured included stand, height July 6, yield to a 15.5 per cent water basis, per cent water at harvest, field weight, and number of ears and nubbins on each plot.

The results obtained indicate (1) that delayed applications alone are not as effective as fertilizer applied at planting time; (2) that splitting the application between planting time and first cultivation may have a slight advantage over applying all at planting time; (3) that a split application in which the fertilizer is applied in equal amounts at all three times to drilled corn may be the most effective method; (This treatment gave a 14 per cent greater yield and 25 per cent fewer nubbins than its nearest competitor, ranked second in low water content at harvest, and gave a greater average field weight per ear than any other treatment). (4) that fertilizer is more effective on checked than on drilled corn; and (5) that better stands are secured from applying fertilizer at planting time. (McClure)

SOME PROBLEMS IN WHEAT IMPROVEMENT

Wheat improvement consists in the development of new varieties, and the program falls naturally into two parts. First, there is the isolation of new strains, usually selections from bulk hybrid populations, and second, the tedious and difficult problem of finding the best among these lines. This is the function of the wheat breeding nursery.

A careful study of a large volume of data suggests that some of the difficulty arises from real differences between strains that cause them to react in dissimilar ways to the same environment. Two examples will be given, show-

ing the differential response of selections to season and spacing of rows. Table 2 gives data from the Wooster nursery which illustrate differential response to season.

TABLE 2.—Differential Response of Wheat Strains to Season

Strain	1933	1934	1935	1936	1937	Average
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Thorne	44.4	47.0	59.3	43.2	52.1	49.2
T. N. 1128	32.2	41.9	43.5	56.4	41.3	43.1
Trumbull	38.3	36.1	49.3	41.7	43.6	41.8

Why did T. N. 1128 yield so well in 1936 when other varieties were barely up to their average performance? Why did Thorne have such a margin over the others in 1935? Each strain was replicated 10 times, and agreement between replicates was good, so that chance errors are practically ruled out as an explanation. If more were known of how wheat strains respond to season and why such differences as those noted exist, perhaps it would be possible to reduce materially the testing work necessary to prove that a new variety is superior.

The second difficulty referred to arises because most small plot work is done in rows spaced 1 foot apart; whereas in field work rows are 6 to 8 inches apart. In some cases varieties do relatively better on one or the other of these spacings. In Table 3 the yields of a selection designated as T. N. 1029 are expressed as per cent of Trumbull yields in the same series of plots.

TABLE 3.—Effect of Spacing of Rows on Relative Yields of Two Wheats

Farm	Between rows	Yields of T. N. 1029 in per cent of Trumbull						
		1930	1931	1932	1933	1934	1935	1936
Wooster	1 ft.	101	101	102	99	101	.....	.....
	7 in.	111	111	112	109	109	.....	.....
Columbus	1 ft.	.....	.....	.....	108	106	102	.....
	7 in.	.....	...	.....	109	107	107	.....
Strongsville	1 ft.	.....	94	94	93	.....	... ...	.....
	7 in.	.....	101	106	107	.....	.....	.....
Holgate	1 ft.	.....	...	.....	.....	.....	106	104
	7 in.	.....	.....	.....	.....	.....	103	104
Germantown	1 ft.	.....	106	106	104	100	104	107
	7 in.	.....	106	106	106	104	104	105
Carpenter	1 ft.	.....	92	96	100	103	102	100
	7 in.	.....	111	110	107	105	107	104

At Wooster, Strongsville, and Carpenter T. N. 1029 yielded, relatively, much better when the drill rows were 7 inches apart than when they were 1 foot apart. At the other farms its reaction was similar to that of Trumbull. The individual farm was much more important than was season in influencing this relationship.

These examples show some of the problems in evaluating new strains of wheat, why the development of a new variety is a slow process, and why the wheat breeding nursery must be so extensive. In Ohio for 1937-1938, the wheat improvement program includes over 10,000 plots, ranging from head rows 3 feet long and spaced 1 foot apart to variety test plots 1/30 acre in extent sown with regular farm machinery. Tests are conducted at 13 points in the State. The program in the past has produced a number of excellent wheats, including Trumbull and Fulhio, which today make up about 80 per cent of Ohio's crop. At present, Thorne is being multiplied for distribution, and on the basis of 10 years' tests, promises to outyield anything now available. In various stages of testing are a number of very promising selections. It is hoped that some of them may prove even better adapted to Ohio conditions than anything so far obtained. (Lamb)

SOIL LOSSES FROM FERTILITY EXPERIMENT PLOTS

The investigation of soil losses due to erosion on the long-time fertility plots, for which a preliminary report was given in 1935, has been continued. Studies were made on the continuous culture plots (wheat, oats, corn), Section C and Plots 1-10 of Section D in the 5-year rotation, and Plots 25-34 of Sections A, B, and C in the potato rotation (3-year rotation).

The soil loss was determined by comparing the profiles of the soil on the plots with those of the uneroded soil in sodded roadways. This was accomplished by making three auger borings every 25 feet the length of each plot (273 feet long)[1]. The uneroded profile used in measuring was 0-14 inches, A horizon, 14-24 inches, B horizon, 24+ inches, C horizon.

TABLE 4.—Soil Loss from Fertility Plots at Wooster*

Cropping system		Average slope		Soil loss	
		Pct.		*In.*	
Continuous culture					
Wheat		4.7	(4.4†)	7.4	(5.9†)
Oats		4.0		5.8	
Corn		2.8		9.1	
Five-year rotation					
Section C, Plots 1-10	unlimed	4.5		11.2	
	limed		4.1		7.7
Plots 11-20	unlimed	4.6		7.1	
	limed		6.1		6.9
Plots 21-29	unlimed	4.1		5.3	
	limed		5.2		6.6
Section D, Plots 1-10	unlimed	2.4		5.2	
	limed		3.8		5.8
Three-year rotation (potato rotation)					
Section A, Plots 25-34		2.0		2.2	
Section B, Plots 25-34		2.6		2.6	
Section C, Plots 25-34		1.5		2.1	

*All tests were started in 1894.
†Excluding the east end of Plots 1-4, parts of which have a slope of 8 per cent.

[1]Through the cooperation of J. S. Cutler, Regional Supervisor of the Third District of the Soil Conservation Service, the field examination of the profiles was made by Dr. H. Howe Morse, Dr. William Ligon, Dr. Helmut Kohnke, and Mr. Leslie Yohn, whose cooperation in this study is deeply appreciated.

A summary of the soil losses by sections is given in Table 4. The values differ slightly from those reported in 1935 as a result of finding new details concerning the history of the plots. The continuous culture and the 5-year rotation experiments are located on a low ridge of land which had been farmed for about 60 years before the land was acquired by the Station in 1893. The potato rotation lies on more gently sloping land than the other experiments. Section A and half of Section B had been cropped for about 40 years before 1893; whereas the remainder of Section B and all of Section C were cleared at that time.

The greatest amount of erosion found, in this study, was on the continuous corn plots and the least, on the potato rotation. The soil loss on Section C and Plots 1-10 of Section D in the 5-year rotation was intermediate between that for the continuous corn and that for the continuous wheat and oats. Sheet erosion has been very severe over most of Section C (throughout two-thirds of the area the B horizon has been turned up in plowing), and shallow gullies have been developed in a few places. Relatively little erosion has taken place on the potato rotation section as is evidenced by the fact that the plowed layer is still in the A horizon.

The effect of treatment on the individual plots in relation to soil losses is difficult to interpret because of the variations in slope. In general, the losses on the check plots are slightly larger than those on the adjacent treated plots on comparable slopes, except in the case of continuous corn. The effect of manure treatment in decreasing the soil loss is most evident on the continuous oats and on the plots of Section C of the 5-year rotation. Less soil has been lost from the limed than from the unlimed ends of the plots on comparable slopes in the 5-year rotation.

Differences in crop yields due to erosion are shown by the yields of wheat harvested from the various parts of the limed end of Plot 11, Section D of the 5-year rotation. The following results were secured: 5 inches of soil lost, yield 32.1 bushels per acre; no soil lost, yield 37.9 bushels per acre; 14 inches of accumulation, yield 48.3 bushels per acre. The average yield for the plot as a whole was 32.6 bushels per acre. (Conrey and Burrage)

MINOR FERTILIZING ELEMENTS INEFFECTIVE IN PRELIMINARY TESTS

Much interest has arisen recently in the possible need for other fertilizing elements than nitrogen, phosphorus, and potassium under Ohio conditions. Two years' results are now available from a "minor element" experiment begun at Wooster in 1936 upon an area of Canfield silt loam depleted in fertility by many years of cropping. The elements being tested are manganese, copper, magnesium, zinc, boron, and sulfur. Each is combined with a basic treatment of nitrogen, phosphorus, and potassium supplied in pure chemical salts and equivalent to 300 pounds of a 2-12-6 annually. The first four minor elements mentioned are supplied as sulfates at the rate of 50 pounds per acre, boron, as borax at the rate of 5 pounds per acre, and sulfur, as calcium sulfate (gypsum) at the rate of 200 pounds per acre. The six minor element treatments and a check are each replicated seven times in a Latin square arrangement. The yields of corn obtained in 1936 and of oats in 1937 are shown in Table 5.

TABLE 5.—Effects of Minor Fertilizing Elements upon the Yields of Corn and Oats on Canfield Silt Loam, Wooster

Treatment*	Average yield per acre	
	Corn, 1936	Oats, 1937
	Bu.	*Bu.*
Manganese	38.6	24.9
Copper	38.6	24.9
Magnesium	38.0	24.6
Zinc	38.8	25.0
Boron	40.0	25.6
Sulfur	38.6	25.9
Check (basic treatment only)	39.3	24.7

*All minor element plots received the same basic treatment as the check. All plots also received an application of high-calcium hydrated lime.

It is obvious from the remarkably uniform yields of all treatments in both years that none of the minor fertilizing elements produced any significant effect. The experiment will be continued with different crops in rotation.

(Barnes)

HYBRID CORN LEADS IN SEVENTH CONSECUTIVE YEAR[2]

The present report summarizing the comparative acre yields of corn hybrids and open-pollinated varieties is the seventh in an annual series. The purpose of this series is to point out possibilities of greater acre yields for the present guidance of the farming public and to put on permanent record an account of the progress being made in this historically important period of corn improvement.

When the first report of this series was published and for several years thereafter, corn hybrids played only a negligible part in Ohio corn production. In 1936 hybrids were grown on only about 2 per cent of the acreage. They comprised about 7 to 9 per cent of the crop just harvested (1937), and sufficient seed has been produced to plant about one-third of the 1938 acreage. To date, the supply of seed has been the factor limiting the acreages planted.

Table 6 shows average yields of both open-pollinated varieties and hybrids in each of 13 experiments variously located in the State in 1936. It also shows the highest yield obtained from any variety and from any hybrid at each location. The hybrids are doubtless somewhat favored in the comparison of the last two columns, since more hybrids than varieties were tested; this gave greater opportunity for chance high fluctuations in the hybrids. Such is not the case in Table 7, where one hybrid (Ohio W17) is selected to compete with the highest yielding variety in each experiment containing Ohio W17.

The fact that W17 averaged lower by 2.3 in percentage of dry matter in the ears at harvest shows that the varieties were, on the average, a little earlier, but not nearly enough so to account for their 12.8 bushels lower yield.

It is significant that W17 was lower than the competing variety in lodged plants in every comparison, and lower in smut infection in all but one. This type of performance is typical of many of the better hybrids.

The Experiment Station does not have hybrid seed corn for sale. County agricultural agents may be consulted for sources of recommended hybrids.

[2]In cooperation with the Division of Cereal Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.

TABLE 6.—Summary of the Comparative Acre Yields of Corn Varieties and Hybrids, 1936

Location of experiments	Open-pollinated varieties			Hybrids			Increases of best hybrids over best varieties	
	Number	Acre yield		Number	Acre yield			
		Average	High		Average	High		
		Bu.	*Bu.*		*Bu.*	*Bu.*	*Bu.*	*Pct.*
Northeast Ohio								
Trumbull County Experiment Farm	15	68	78	48	83	93	15	19
Belmont County Experiment Farm	5	57	67	20	69	80	13	19
Experiment Station (Wooster)	6	72	77	63	85	96	19	25
Northwest Ohio								
Paulding County Experiment Farm	10	45	50	15	55	62	12	24
Northwestern Experiment Farm (Holgate)	10	43	48	90	54	64	16	33
Central Ohio								
Ohio State University (Columbus)	1	35	35	19	39	47	12	34
Ohio State University (Columbus)	1	32	32	6	38	44	12	38
Ohio State University (Columbus)	1	28	28	6	37	41	13	46
Southwest Central Ohio								
Miami County Experiment] Farm	5	41	44	92	53	70	26	59
Southwestern Experiment Farm (Germantown)	3	43	52	67	46	62	10	19
Southern Ohio								
Hamilton County Experiment Farm	9	46	51	16	55	68	17	33
Clermont County Experiment Farm	5	30	34	15	43	51	17	50
Southeastern Experiment Farm (Carpenter)	6	36	42	14	52	57	15	36
Totals	77	.....	.....	471	.....	.....	.....	.....
Averages	.....	44.3	49.1	.....	54.5	64.2	15.1	30.8

TABLE 7.—Ohio Hybrid W17 Compared with the Highest Yielding Open-pollinated Variety in Each of Seven Experiments, 1936

Place	Acre yield (bushels)		Dry matter at harvest (per cent)		Lodged plants (per cent)		Smutted plants (per cent)	
	Variety	W17	Variety	W17	Variety	W17	Variety	W17
Trumbull	78.1	92.6	63.5	59.2	26.2	1.4	1.3	2.4
Wooster	76.9	91.5	60.8	57.1	66.4	16.8	5.4	1.4
Belmont	67.2	80.3	61.0	62.0	30.1	3.3	7.1	0.6
Northwestern	47.5	58.5	79.6	77.2	38.2	14.7	3.7	1.0
Paulding	49.7	62.2	68.1	61.1	5.4	2.5	2.8	1.7
Columbus A	31.9	40.8	79.3	78.2	29.8	0.6	...	...
Southeast	41.8	56.8	74.0	75.3	16.2	5.5	2.4	0.7
Average	56.2	69.0	69.5	67.2	30.3	6.4	3.8	1.3

(Stringfield)

PERFORMANCE OF EARLY VARIETIES OF OATS

Some early maturing varieties of oats that are new to Ohio have made excellent yield records in tests in western and southern Ohio where early oats are adapted. Nursery yield trials are conducted at four places in that general region: Columbus, the Northwestern Test Farm at Holgate, the Southeastern Test Farm at Carpenter, and the Southwestern Test Farm at Germantown. Table 8 includes only certain varieties that have made superior records and a few important commercial varieties for comparison. Yields at Wooster are included, although Wooster is in the area where late white varieties are adapted and are generally grown in preference to early ones.

TABLE 8.—Yields of Promising New Varieties of Oats Compared with Standard Varieties

Variety	Columbus 7 years	Southwestern Test Farm 7 years	Southeastern Test Farm 7 years	Northwestern Test Farm 3 years	Wooster 4 years	Color of kernels
Columbia	56.8	.....	.....	.....	55.6	Gray
B. x R.R.P. 55	55.9	42.4	37.1	63.1	55.1	White
Albion	53.4	.....	.....	49.3	.....	White
F 22048 W	52.5	38.6	32.5	.....	.....	White
Franklin	52.2	34.0	30.2	46.0	50.3	Red
Iogold	51.7	.....	.....	.....	.....	Yellow
Gopher	51.3	.....	.....	56.2	53.2	White
Sixty Day 1636	50.2	32.9	30.2	48.0	.....	Yellow
Hybrid 2525 W	49.6	38.2	31.8	.....	22.1	White
R.R.P. 2242	48.4	35.1	30.4	53.3	57.1	Red
Iowar	47.6	.....	.....	.....	53.3	White
Wayne	41.5	.....	.....	47.9	47.3	White
Miami	41.3	29.4	25.7	50.4	47.0	White
Sixty Day 22485	.....	.....	.....	.....	58.6	White

The varieties that stand out are Columbia, Gopher, and B. × R. R. P. 55.

Columbia is an early maturing gray oat that was bred by the Missouri Station. It has been tested at Columbus, Wooster, and for 1 year at Holgate. At Columbus in a 7-year test, Columbia is 4.6 bushels ahead of Franklin, which is the highest yielding commercial variety. Even at Wooster, Columbia is above any commercial variety and is exceeded only by a few new strains that are not yet in commercial use.

Columbia matures 10 days ahead of Miami. It has a short straw, medium in stiffness. Compared with Franklin, Columbia is earlier, has shorter, weaker straw and lighter-colored grain.

Gopher is an early white oat that was bred by the Minnesota Station. It is 2 to 5 days later than Columbia, slightly taller, and has about the same strength of straw.

B. × R. R. P. 55, a new strain of hybrid origin developed by the Ohio Station, has not been released for commercial growing. It has made a high yield record in all of the tests. It matures with Columbia, is slightly shorter, and is similar in stiffness of straw. Its advantage over Columbia is the white color of the grain. Decision has not been made whether or not to name and release this strain as a new variety.

Aside from yield, early maturing varieties of oats have the advantage of making a better companion crop for starting new seedings of clover. An objection is that in a dry season and on thin soil the straw may be so short that it is difficult to harvest. (Park)

NEW WHEATS HAVE GOOD QUALITY

A new wheat, Thorne, was released in the fall of 1937. Thorne is the result of a cross made in 1917 between the varieties Portage and Fulcaster. It has ranked high in field tests in various parts of the State. However, before being considered worthy of distribution, this new variety had to show that it possessed satisfactory milling and baking qualities in addition to satisfactory field performance.

During its early history, Thorne wheat was tested as T. N. 1006 and under this test number was milled and baked for several years as samples became available. As a final test, samples were produced under comparable environmental conditions with other known varieties or promising strains at several county farms during the period 1933-1936 inclusive. As the resulting data for 1933 were somewhat incomplete, this year was excluded in compiling the averages shown in Table 9.

In this milling and baking study the older and well-established varieties, Trumbull and Fulhio, were included as check varieties. Thorne (as T. N. 1006) and T. N. 1029 were two of the most promising Ohio selections under test; whereas Purdue No. 1 was a new and promising Indiana variety.

The data obtained show that all three of these new wheats possess satisfactory milling and baking characteristics. The quality of the protein or gluten in Thorne is shown to be good, since a smaller amount produced as satisfactory loaves as the check variety, Trumbull. (Bayfield)

LIVESTOCK VERSUS GRAIN FARMING

In 1910 the Ohio Station began an experiment in which two systems of farming were compared. The crop rotation followed in each system was corn, soybeans, wheat, and clover. For the first 20 years red clover was used in both systems. At the end of 20 years sweet clover was substituted for the red in the grain farming system, as it was thought that the grain farmer would be more likely to use sweet clover when the main object was the maintenance of fertility.

A uniform tract of 9 acres was divided into equal parts. One-half is farmed in livestock; the other, in grain farming. In the livestock system all the crops grown except wheat grain are either fed to cattle or passed into the manure as bedding. The cattle are kept in a covered shed. The manure is allowed to accumulate until the feed is exhausted; then it is hauled and spread on the clover sod to be plowed under for corn. Each livestock tract accordingly receives an application of manure every 4 years. The amount of the application depends upon the size of the crops of the preceding year. As a 27-year average, the amount of manure has been 15.42 tons per acre.

In the grain system the corn, soybean seed, wheat, and, for the last 7 years, the sweet clover seed have been sold. The corn is husked on the stalk, and the stover is plowed under for soybeans. The soybean haulm and a part of the wheat straw are applied as a winter mulch on the wheat, and the remainder of the straw, together with the clover haulm, has been put back on the field in clover to be plowed under for corn. No clover is cut for hay.

All land going into corn in both systems received 2 tons of limestone per acre until 1931. It has been omitted since then as not needed. The cornland also receives 320 pounds of 20 per cent superphosphate. In addition to the above, the corn in the livestock system receives the manure made, which has averaged, as stated above, 15.42 tons per acre.

TABLE 9.—Average Percentage of Wheat Protein and Loaf Volume for Five Varieties Grown During 1934-1936 Inclusive

County Farm	Wheat protein						Loaf volume*					
	Trumbull	Fulhio	Thornet†	Purdue No. 1	T. N. 1029	Five varieties	Trumbull	Fulhio	Thornet†	Purdue No. 1	T. N. 1029	Five varieties
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*	*Cc.*
Mahoning	11.8	11.8	11.3	11.1	11.5	11.5	564	563	568	578	594	574
Meigs	10.4	10.1	9.5	9.5	10.0	9.9	541	530	508	535	523	528
Clermont	10.6	10.3	9.5	9.0	9.9	9.9	507	521	505	495	568	519
Montgomery	11.4	11.1	10.3	10.6	10.7	10.8	546	585	542	549	549	554
Miami	12.1	12.4	11.2	11.2	12.1	11.8	571	566	577	562	587	572
Madison	10.2	10.0	9.5	9.4	9.8	9.8	545	561	542	536	569	551
Franklin	12.1	12.3	11.6	11.7	12.6	12.1	582	605	578	603	607	595
Wayne	13.0	13.2	12.4	12.1	12.6	12.7	552	578	598	569	590	577
All eight farms	11.5	11.4	10.7	10.6	11.1	11.1	551	561	552	553	574	559

*Baking procedure: straight dough method, 3-hour fermentation, variable absorption, 100 gm. of flour, 5 per cent sugar, 1 per cent salt, 3 per cent yeast, 1 mg. potassium bromate.

†Distributed in 1937, formerly known as T. N. 1006.

The soybean crop receives no treatment, but the wheat in both systems receives 240 pounds of 20 per cent superphosphate per acre.

Aside from the use of manure in the livestock system, and the use of all roughages, including the hay or clover haulm, in the grain system, both tracts are treated alike.

The crop yields per acre in the two systems are shown in Table 10.

TABLE 10.—Crop Yields per Acre, 1910-1936

	First 10-year period	Second 10-year period	Twenty-year average	Seven-year average, 1930-1936
Ear corn, bu.				
Livestock farming	67.3	86.3	76.8	70.0
Grain farming	59.2	79.8	69.5	69.2*
Difference	8.1	6.5	7.3	0.8
Soybeans, bu.				
Livestock farming	21.7	25.1	23.4	27.7
Grain farming	19.1	22.0	20.5	26.8
Difference	2.6	3.1	2.9	0.9
Wheat, bu.				
Livestock farming	32.5	33.8	33.1	36.1
Grain farming	29.4	29.7	29.6	29.3
Difference	3.1	4.1	3.5	6.8
Clover hay, tons				
Livestock farming	2.24	2.68	2.46	2.08
Sweet clover seed, lb.				366
Sweet clover haulm, lb.				3160
Grain farming				

*Two very poor corn crops in last 7 years.

There has been considerable variation in yield different years. Apparently, varying climatic conditions affect these systems of farming differently. Heavy growth of sweet clover, when allowed to ripen seed, has furnished an amount of woody material not very beneficial to the following corn crop in dry seasons. (Williams)

TURF AND SOIL TYPE AFFECT RATE OF LOSS OF SOIL MOISTURE

To note the rate of loss of water from different surfaces a turf experiment was started in pans in May, 1936. The pans were of such size that they and their contents could be handled easily in weighing. In the pans were used Wooster silt loam and certain modifications of it. Part of the pans were left bare and part were sown with turf grass seeds. After the grass was established all the pans were watered at such intervals as necessary to keep the grass in a thrifty condition. The watering was accomplished by placing the pans on a Troemner balance, noting the weight, and then adding water until the initial weight was restored. The difference in weight before and after watering was regarded as the water loss. The series of pans was located in close proximity to the Station's Standard Weather Bureau Pan, from which the daily rate of evaporation was recorded also. The grass was clipped as necessary to simulate lawn conditions.

Among the results obtained were the following:

1. The evaporation of water was greater from the free water surface than from the Wooster silt loam or any modification of it.

2. The incorporation of peat to a depth of ½ inch in the surface of the Wooster silt loam inhibited the evaporation of moisture.

3. The incorporation of a liberal quantity of well-rotted stable manure with the Wooster silt loam also lessened the loss of moisture.

4. The loss of moisture from the Wooster silt loam alone, the Wooster silt loam with the surface of which peat was incorporated, and the Wooster silt loam mixed with manure, each without grass, was less than the loss from the same surface covered with growing grass.

5. The loss of moisture was greater from high than from low clipping.

(Welton and Wilson)

WHITE CLOVER STRAINS

For three reasons white clover is highly valued in permanent pasture.

In the first place, it enriches the herbage by its own high protein and high mineral content. Second, with favorable weather and soil conditions it makes more growth than grass during the summer and fall and helps to even up the production, thus giving a more nearly uniform and constant supply of pasture. In the third place, white clover, by increasing the nitrogen supply, increases the growth of grass grown with it.

Experiments have shown that the white clover content is greatly modified by time, closeness and frequency of grazing, the lime and phosphate content of the soil, and the amount of moisture available.

It has been observed that white clover generally disappears with hot, dry seasons. Corn Belt, Louisiana, Kent, and Ladino white clovers represent strains with certain significant differences in habits of growth. It is believed that there may be many other strains represented in our native wild white clover. Therefore, it seemed advisable to make a closer study of these better-known and other strains for the purpose of determining their ability to persist under various conditions of fertilization and grazing and with the variations in

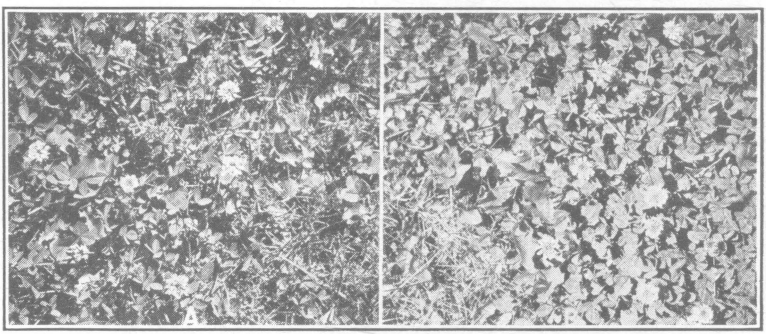


Fig. 1.—Two strains of native wild white clover. A has small leaves without markings and spreads rapidly through the blue-grass sod, but the 3 weeks' growth shown here has not over-shadowed the grass. B has larger leaves, spreads less rapidly, but grows taller and in 3 weeks from clipping has largely over-shadowed the grass.

TABLE 11.—The Effect of Very Close Grazing, Lime, and Fertilizer on the Stand and Persistance of Different Strains of White Clover in a Kentucky Bluegrass Sod. Lane Pasture, Fry Farm, Wooster, June 24, 1937

The data indicate the percentage of the plot area occupied by white clover, the gain made by each strain over the corresponding unseeded section, and the gains resulting from the different treatments.

Strain of clover	No treatment		800 pounds of 0-20-0			800 pounds of 0-20-0 and lime			1200 pounds of 0-14-6 and lime		
	Clover (per cent)	Gain over no seeding	Clover (per cent)	Gain over no seeding	Gain over no treatment	Clover (per cent)	Gain over no seeding	Gain over no treatment	Clover (per cent)	Gain over no seeding	Gain over no treatment
Not seeded*	2.2	.....	3.6	.....	1.4	9.8	.....	7.6	10.2	.....	8.0
Louisiana White	10.5	8.3	17.8	14.2	7.3	19.3	9.5	8.8	24.3	14.1	13.8
Corn Belt White	9.0	6.8	13.8	10.2	4.8	17.0	7.2	8.0	16.0	5.8	7.0
Kent Wild White	14.0	11.8	20.8	17.2	6.8	31.3	21.5	17.3	36.3	26.1	22.3
Ladino	4.3	2.1	2.3	— 1.3	—2.0	9.0	— 0.8	4.7	12.3	2.1	8.0

*The presence of clover in the no seed section is due to volunteer white clover.

season characteristic of Ohio. In addition to the better-known strains, native wild strains were collected from Franklin, Butler, Hamilton, Muskingum, Pike, Madison, Lorain, Fairfield, Carroll, Jackson, and Preble Counties, Ohio, and from West Virginia, Louisiana, and New York. Other lots were obtained from England, New Zealand, Sweden, and Canada.

Although the tests involving these have not run sufficiently long to justify any conclusions, very decided differences have been observed as may be noted in Figure 1.

Two or more of these strains are involved in nine different tests. Results from one of these will serve to indicate some of the differences being observed. This test is located in a very closely grazed section of Kentucky bluegrass on the Fry Farm at Wooster. The clovers were seeded on the bluegrass sod in the spring of 1936. The results, as indicated by a reading on June 24, 1937, are summarized in Table 11.

All of the four strains responded to the additions of lime and fertilizer and with two minor exceptions made their best showing with lime, phosphate, and potash.

Under the very close and continuous grazing conditions obtaining, Kent wild white has persisted best. No yields were obtained, but it appears that they would have been low, as would be expected under such conditions of grazing. (Dodd)

BACTERIAL WILT OF ALFALFA IN OHIO

The presence of bacterial wilt has been recognized in Ohio for many years, but widespread general injury was not noticed until 1936-1937. The severe freezing of 1935-1936 injured the roots, affording entrance to the bacteria. Consequently, bacterial wilt was generally present in alfalfa in the western half of Ohio by the fall of 1936. These wilt-infected plants were not generally recognized, but were heaved during the winter of 1936-1937. This heaving gave rise to much of the "winterkilling" of alfalfa during that winter.

Number of cuttings has had an important effect on incidence of wilt through affecting the amount of winter cover. For example, a plot of alfalfa at Columbus cut only twice in 1935, the last cutting August 11, went into the severe winter of 1935-1936 with 15 to 20 inches of growth. The adjacent plot, cut again September 30, had practically no cover. Despite severe injury to the roots of the latter plot, the yields of the two were similar in June, 1936, but by September, 1936, there was at least 80 per cent of wilt infection in the late-cut plot. In 1937 it was practically dead; whereas the two-cutting plot was still good.

Similarly, at Holgate, the only plots in the time-of-cutting series sown in 1932 which produced even a moderately good crop in 1937 were the two-cutting plots.

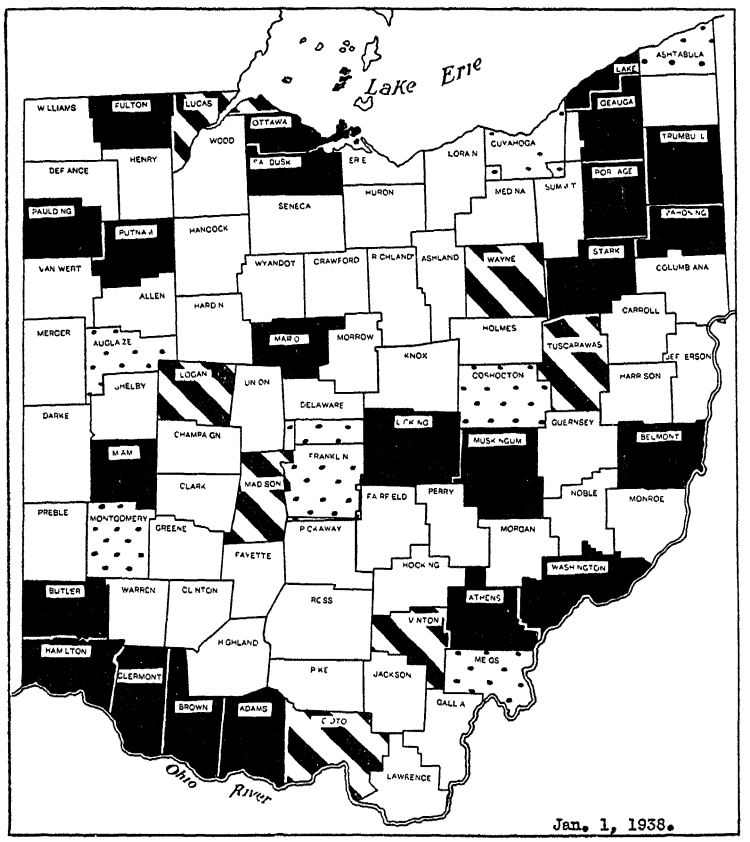
In the plots at Columbus, bacterial wilt has been just as destructive of alfalfa in alfalfa-grass mixtures as of alfalfa sown alone.

Bacterial wilt has been much more severe on black soil (Brookston) than on gray-brown soil (Miami).

In an alfalfa variety test sown at Columbus in 1933, the only varieties of which more than scattered plants are left on Brookston soil are Turkestan and Hardistan. Ladak, which has some resistance to wilt in the West, went out early and completely. This may not have been due to wilt, but the variety is undesirable in Ohio, despite high yields for a short period after seeding.

The ultimate solution for the bacterial wilt problem is resistant varieties which are otherwise adapted to the State, and a breeding program toward this end is in progress. Seed of resistant varieties is not now available, and the present resistant varieties are not as desirable otherwise as the variegated varieties which are now standard for the northern two-thirds of the State. At present it seems desirable to continue using both the varieties and cutting practices which have been recommended previously. Wilt does not attack young stands, so that at least 2 years of satisfactory yields can be obtained in any event, and it may be some time before conditions are again favorable for so severe an attack of the disease. (Willard)

THE OHIO SOIL SURVEY



Surveys completed, reports published

Prior to 1912

Reconnaisance survey in 1912

Since 1912

Surveys in progress

Field work completed, report in publication

Fig. 2.—Progress of Ohio Soil Survey

During 1937, the soil survey operations have been continued in Tuscarawas County by the Experiment Station in cooperation with the United States Bureau of Chemistry and Soils; the field work in this county has been practically completed. Figure 2 shows the progress of the soil survey in Ohio to date. The supply of reports for Paulding, Portage, and Trumbull Counties available for distribution has been exhausted. Reports for Licking, Adams, and Athens Counties will be available early in 1938. (Conrey)

SOME EFFECTS OF CROP ROTATIONS ON YIELDS AND SOIL NITROGEN

Crop rotations affect the productivity of soils in two ways: (1) favorably, through adding plant residues to the soil and (2) adversely, through tillage practices which hasten the destruction of soil organic matter. A proper balance between these two processes is necessary if the productivity of the soils is to be maintained or increased[3]. The sod crops, especially legume sods, tend to increase the soil organic matter and nitrogen. Such crops as corn, potatoes, tobacco, and other intertilled crops decrease these constituents rapidly. The small-grain crops, wheat, oats, barley, rye, and others are also destructive but less so than the intertilled or "hoed" crops.

The influence of different crop rotations upon soil productivity is shown by the Crop Rotation Experiment (No. 23) started at Wooster in 1915 and comprising 40 different rotations and five crops in continuous culture. The treatments with lime, fertilizer, and manure have averaged the same per acre per year for all rotations, i. e., 200 pounds of 6 per cent superphosphate and 2 tons of stable manure. The lime applications have been uniformly 2 tons of ground limestone per acre every 4 years.

Data for six 5-year rotations are shown in Table 12 and serve to illustrate the effects of varying the number of soil conserving and soil depleting crops in the rotation. The yields of corn only are given, since corn is somewhat more sensitive to changes in soil productivity than are some of the other crops.

Rotation No. 40, which included 3 years of alfalfa has produced more corn than Rotation No. 32, which included 3 years of clover-timothy meadow. The first hay harvested in No. 32 has contained much clover, but the last has been almost pure timothy. The superiority of Rotation No. 40 over Rotation No. 32 was outstanding during the second and third periods, but the two yielded about the same during the fourth period. The yields during the latter period were reduced by the drouth, and the corn crops planted on a 3-year-old alfalfa sod suffered somewhat more damage than did corn following a clover-timothy meadow.

Rotations No. 40 and No. 32 have both increased in productivity as a comparison of their yields with the "base yields" shows. The nitrogen content of the soils has increased also, as is shown by comparing the amount in the soil in the spring of 1936 with the amount at the beginning of the experiment.

Rotation No. 31 contains the proportion of 2 years of soil conserving sod crops to 3 years of soil depleting grain crops, corn, oats, and wheat. This rotation appears to have maintained productivity on a fairly even basis, and the supply of soil nitrogen has been well maintained. Apparently, the soil on the plots in this rotation was originally a little less productive than that in the other rotations discussed.

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[3]The productivity of soils is strongly correlated with the organic matter and nitrogen contents.

TABLE 12.—Acre Yields of Corn in Some 5-year Rotations and their Effect upon the Total Nitrogen Content of the Soil (Crop Rotation Experiment 23), Wooster

	Rotation periods (five corn crops in each period)									
	First period* 1915–1919	Second period 1920–1924		Third period 1925–1929		Fourth period 1930–1934		Summary of second, third, and fourth periods		Total nitrogen per acre, spring of 1936†
	Average yield per acre	Average yield per acre	Increase+ or decrease—‡	Average yield per acre	Increase+ or decrease—‡	Average yield per acre	Increase+ or decrease—‡	Average yield per acre	Average increase+ or decrease—‡	
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*
Base yield, 30 rotations	68.0	64.0	.....	85.1	.....	54.6	.....	67.9	.....	.....
Order of crops in rotation										
Number 40 Corn, oats, alfalfa, alfalfa, alfalfa	63.4	75.2	+11.2	102.7	+17.6	62.0	+7.4	80.0	+12.1	2508
Number 32 Corn, wheat, clover-timothy, timothy-clover, timothy	68.6	69.3	+ 5.3	92.2	+ 7.1	62.3	+7.7	74.9	+ 7.0	2480
Number 31 Corn, oats, wheat, clover-timothy, timothy-clover	66.6	64.7	+ 0.7	86.4	+ 1.3	53.2	—1.4	68.1	+ 0.2	2460
Number 33 Corn, corn, wheat, clover-timothy, timothy-clover — First corn crop	68.1	69.7	+ 5.7	87.9	+ 2.8	55.1	+0.5	70.9	+ 3.0	2396
Number 33 Corn, corn, wheat, clover-timothy, timothy-clover — Second corn crop	56.9	59.9	— 4.1	73.7	—11.4	53.4	—1.2	62.3	— 5.6	
Number 35 Corn, corn, soybeans, wheat, clover — First corn crop	71.2	69.4	+ 5.4	89.6	+ 4.5	50.1	—4.5	69.7	+ 1.8	2212
Number 35 Corn, corn, soybeans, wheat, clover — Second corn crop	60.7	61.4	— 2.6	76.4	— 8.7	57.2	+2.6	65.0	— 2.9	
Number 38 Corn, corn, corn, wheat, clover — First corn crop	68.0	64.6	+ 0.6	89.2	+ 4.1	47.2	—7.4	67.0	— 0.9	2072
Number 38 Corn, corn, corn, wheat, clover — Second corn crop	65.0	56.3	— 7.7	70.9	—14.2	52.9	—1.7	60.0	— 7.9	
Number 38 Corn, corn, corn, wheat, clover — Third corn crop	56.8	54.3	— 9.7	70.5	—14.6	49.5	—5.1	58.1	— 9.8	

*Yields not much affected by rotations during this period.
†Approximate content at beginning of experiment in 1915, 2375 pounds.
‡Increase or decrease as compared with base yields (average for 30 rotations).

Rotation No. 33 differs from Rotation No. 31 in that a second corn crop replaces oats. Theoretically, this should make No. 33 a less desirable rotation than No. 31. Actually, the yield of corn is slightly higher in Rotation 33, although the nitrogen content of the soil in 1936 was lower. The yields during the first period suggest that the plots in Rotation 33 may have been higher in fertility at the start of the experiment. The difference between the two rotations seems largely to have disappeared in the third and fourth rounds of the rotations.

Rotations No. 35 and No. 38 each contain four grain or soil depleting crops (three of them intertilled) and one soil conserving clover crop. Rotation No. 35 contains two corn crops and a soybean crop; the latter is planted in rows and cultivated. The soybeans were harvested for grain for part of the 20-year period and for hay the other part. Rotation No. 38 contains three corn crops. The soybeans in No. 35 appear to have been less detrimental to the corn crops (first and second crops in each rotation) than was the third corn crop in No. 38. The soil nitrogen also remained at a little higher level in No. 35 than in No. 38. However, both of these rotations resulted in a loss of soil nitrogen in spite of the liberal amounts of manure and superphosphate fertilizer applied to them.

(Thatcher and Salter)

BOTANY AND PLANT PATHOLOGY

APPLE TREE MEASLES

The "measles" investigation has been in progress at this Station for several years. Before 1936 all of the studies were devoted to the finding of a causal agent, and it was assumed that some parasite was involved. Hundreds of isolations were all negative. Grafting and budding from diseased trees to healthy young trees failed to reproduce the disease. Likewise, juice from diseased trees injected into healthy trees failed to transfer the disease.

Soil deficiency studies were tried next. Seven series of four Red Delicious trees each were grown for two seasons in Shive's complete nutrient R_3S_8, one-half atmosphere concentration, in purified sand cultures. Series 1 was fed the nutrient solution and the remaining six were given in addition 1, and 2 parts per million of boron, zinc, and manganese, respectively. During the first season, only differences in growth were noted. The boron series made about twice the growth of any of the others. After about 30 days of the second season, pimples began to appear generally, except where boron was fed. The inner bark of these pimply trees showed a typical necrotic condition similar to the "measles" occurring in the orchard. When these pimply trees were fed boron they gradually recovered. In 1937, borax, boric acid, and Boracite were applied to diseased apple trees in the orchard. Since the recovery of "measles" trees is slow, no results of these field tests are as yet evident.

Although it cannot be certain at this time that we are dealing with the same disease that is called "measles", the facts point to deficiencies as a cause, and the addition of boron to sick trees would seem advisable.

(Young and Winter)

APPLE SCAB STUDIES

The season of 1937 was very favorable for the development of scab. Rains were frequent and spore-shooting periods were numerous. Even under these conditions the disease in the test orchards was easy to control. The homemade wettable sulfurs used throughout the season gave excellent control at Barnesville. At Wooster these wettables, as well as some of the commercial types, were not thoroughly satisfactory, even when they followed a regular preblossom schedule of lime-sulfur However, the results indicate that a schedule comprising lime-sulfur in the preblossom, followed by a one-half strength dry or liquid lime-sulfur plus 4 or 5 pounds of dusting sulfur, or a standard wettable sulfur, should prove effective. Flotation sulfur paste used with or without lime-sulfur was effective. Reducing the strength of the lime-sulfurs and supplementing them with uncombined sulfurs caused much less foliage injury and better fruit finish. (Young and Winter)

CHERRY LEAF-SPOT CONTROL

An extensive series of spray tests was conducted during the 1937 season in a commercial cherry orchard near Fremont. The season was very favorable for leaf-spot development, and control was difficult. Unsprayed check trees were entirely defoliated before harvest.

The standard spray materials, liquid and dry lime-sulfur, recommended generally for leaf-spot control, failed to check the disease satisfactorily. These materials, as well as combinations of lime-sulfur, one-half strength, plus 5 pounds of dusting sulfur or wettable sulfurs per 100 gallons of spray, controlled fairly well up to harvest but failed later.

Bordeaux mixture, 4-6-100, gave excellent leaf-spot control but caused severe injury, resulting in leaf drop.

Three insoluble copper compounds were tested, namely, Cupro-K, Grasselli Copper Oxychloride, and Coposil. These materials were remarkably effective. Almost perfect control was obtained, and very slight injury resulted. Injury occurred only with the first application. It is suggested that an amount of lime equal to the weight of the copper material be used in the early sprays to prevent this slight injury. (Young and Winter)

PEACH SCAB AND BROWN ROT CONTROL

Spraying tests were conducted in two northeastern Ohio peach orchards during the 1937 season. Comparison was made between a low-cost homemade wettable sulfur and a higher cost commercial brand. The homemade wettable consisted of 8 pounds of dusting sulfur, 4 ounces of dried skim milk, and ½ ounce of Aresklene. These materials were mixed dry and added to the tank at the rate of 8 pounds per 100 gallons of water. The commercial wettable sulfur was used at the same rate.

An attempt was also made to determine which applications of those in the schedule were most effective in controlling scab and brown rot.

The results indicate that the homemade wettable and the commercial wettable sulfurs are equally effective in controlling both diseases. One application of either material applied June 30, 3 weeks after shucks-fall, held scab infection to an average of 1.5 per cent on the fruits of Greensboro, Elberta, and Lemon Free. The unsprayed checks showed an average of 95 per cent fruit infection. The addition of a fungicide to the shucks-fall spray failed to give any increase in control of either scab or brown rot. The preharvest spray, applied 2 weeks before harvest, was very important for the control of brown rot but was of no benefit for scab control. (Winter and Young)

STEAM VAPOR SPRAYING

The steam vapor sprayer developed by R. M. Merrill and his associates in the Agricultural Engineering Division of the United States Department of Agriculture was tested again during the 1937 season. Perfect control of peach leaf curl was obtained when the recommended strength of lime-sulfur was applied with the steam vapor sprayer. When lime-sulfur was applied for the control of apple scab and cherry leaf spot, better results were obtained from the use of the steam outfit than by the use of the conventional type of sprayer. Sulfur and lime combinations, with gelatine as a wetting agent, gave excellent control of all three diseases when applied by the steam rig. The heat generated within the sprayer brought about a chemical combination of the sulfur and lime to form a polysulfide material similar to lime-sulfur. Dusting sulfur made wettable with gelatine and applied with the steam vapor sprayer controlled apple scab and cherry leaf spot more effectively than lime-sulfur applied in the conventional manner. The heat developed in the sprayer was sufficient

to melt the sulfur, and when this was vaporized at the nozzle, a considerable portion of the sulfur particles were found to be amorphous in structure. Such amorphous sulfur particles have been found to be more toxic to fungi and to adhere better to plant foliage. Bordeaux mixture, 12-12-100, applied with the steam sprayer failed to control peach leaf curl. The action of the heat changed the color of Bordeaux to a muddy brown and markedly reduced its fungicidal efficiency.

About one-third the normal amount of spray materials and water was found necessary for adequate coverage. Thus, a saving in materials cost is effected which is about offset by increased fuel cost. Spraying with the present steam outfit is slow, and the future of the steam sprayer depends largely on the development of a workable machine which will apply the sprays more rapidly. (Winter and Young)

POTATO SPRAYING

Seven applications of spray were made in a potato spraying experiment with Irish Cobblers at Wooster during 1937. The experiment was primarily for the control of hopperburn and early blight. The materials used and the yields were as follows:

Control, no spray	107 bushels per acre
4-6-50 Bordeaux	272 bushels per acre
4-3-50 Bordeaux	241 bushels per acre
Cupro-K, 25 per cent copper	224 bushels per acre
Basic copper sulfate	168 bushels per acre

(Tilford)

COMPARISON OF LOW-SOLUBILITY COPPER COMPOUNDS AS VEGETABLE SPRAYS

Experiments designed to determine finally, if possible, the best substitute for Bordeaux mixture as a spray for those vegetables susceptible to injury by fungicides were continued and enlarged in their scope during the past year. The materials used and the crops treated are shown in Table 13. In general,

TABLE 13.—Comparative Yields Obtained in Treating Vegetables with Various Copper-containing Spray Materials in 1937

Crop	Location	Check	Bordeaux mixture	Cupro-K	COC-A	Copo-sil	Hydro 40	Cupro-cide	Super Copper	Palus-trex
Cucumbers	Wooster..	57	114	152	166	164	.....	.....	.....	.....
Cucumbers	McGuffey.	492	822	863	966	.....	963	.....	.....	.....
Cucumbers	Bowling Green...	.....	.....	401	457	385	374	.....	.....	.....
Cucumbers	Norwalk..	170	236	281	288	322	280	.....	.....	.....
Muskmelons.....	Wooster ..	463	579	663	690	670	.....	.....	.....	.....
Tomatoes .	Wooster ..	672	373	608	598	.....	.....	.....	.....	.....
Tomatoes .	Wooster ..	.....	180	197	195	194	206	172	.....	.....
Tomatoes .	Elyria....	403	473	561	484	570	465	471	.....	.....
Tomatoes .	Bowling Green...	191	440	457	515	.....	499	477	.....	.....
Carrots....	Elyria....	57	81	93	80	84	83	56	48	.....
Celery.....	Copley....	166	269	257	279	273	250	244	224	197
Ginseng* ..	Coshocton.	0	88	20	87	33	44	32	48	0

*All data are given in pounds per plot except those for ginseng, which are recorded as percentage of total plants escaping disease.

the various copper-containing materials were used in such concentrations that the metallic copper contents of all mixtures were the same on a given crop. This was not true for Super Copper and Palustrex, however, where the copper content was smaller.

A consideration of the results leads to much the same conclusion as was arrived at in 1936, namely, that the copper oxychlorides offer the most promise of the many new materials which have so far been introduced. COC-A gave excellent results in over half of the instances in which it was used. Cupro-K, another oxychloride, was also effective. Coposil, a silicate of copper, provided good results in some instances. Results obtained with Bordeaux mixture in various copper sulfate – hydrated lime ratios were conflicting this year. The 4-2-50 formula gave better control of ginseng blight than either a 4-4-50 or a 2-4-50 and caused considerably less foliage injury and blossom drop on tomatoes than did a 4-4-50. However, on celery the 4-2-50 mixture was much less effective in controlling late blight than was a 4-4-50. The addition of zinc to the 4-4-50 formula had very little effect in reducing injury to staked tomatoes. The fungicidal efficiency of Bordeaux mixture appeared to be reduced somewhat more than that of most of the low-solubility copper compounds when applied with a vapor sprayer. (Wilson and Runnels)

FUSARIUM SUSCEPTIBILITY IN CELERY VARIETIES

Forty-six celery varieties were planted in eight different fields in northern Ohio in 1937. These fields were known to be infested to some degree, at least, with the yellow organism (*Fusarium apii*, Nelson and Sherbakoff). Data were finally collected from five fields, and the results given here are the averages of these. Varieties in which 20 per cent or more of the plants were affected were: Accession 191, Early Fortune, California Golden 14, Golden Self Blanching, Golden Phenomenal, Gunson's Special, Hoover's Special, Meisch's Special, New Bunching, Wonderful, White Plume, Golden Detroit, and Golden 14. Less than 5 per cent of the plants were affected in 18 varieties, and the remaining 15 varieties showed disease percentages ranging between 6 and 19. The present plan is to repeat this test during each of the next 3 or 4 years, with the successive elimination of all varieties showing over 20 per cent of yellows. (Wilson)

EVAPORATION AT WOOSTER IN 1937

Evaporation during the months of May to September, inclusive, was the lowest in 10 years. The effect of light, as measured by the difference in loss between black and white atmometers, accounted for the largest percentage of the total loss in the 10-year period. Rainfall from May to September was below the 10-year average and this, with a low evaporation rate, resulted in an evaporation-rainfall ratio which was near the average. This ratio was low for May and June (wetter than average) and slightly higher than the average (drier) for July, August, and September. Indirect radiation was responsible for about 38 per cent of the total evaporation due to sunlight. (Wilson)

TOXICITY OF LOW-SOLUBILITY COPPER COMPOUNDS ON GLASS SLIDES

When the germination of spores of *Glomerella cingulata* on untreated slides was 88 per cent, that with Bordeaux mixture was 1.2 per cent, and only five of the 10 copper compounds of low solubility held germination below 25 per

cent; whereas, for the other five the germination percentages ranged from 33.6 to 88. The fungicides were used at the rate of ⅛ pound in 50 gallons on the basis of a compound containing 25 per cent of metallic copper, spreaders at a dilution of 1 to 600, and diluents at the rate of 1 pound in 50 gallons.

During the progress of the experiment there was some indication that the spreader being used was toxic to spore germination, and for this reason a further test was made involving seven spreaders used independently of copper-containing materials. A number of these, at a dilution of 1 to 600, held germination to the low figure of 5 per cent, when 92 per cent of the spores germinated with no treatment. (Runnels and Wilson)

TREE WOUND DRESSINGS

A study has been made of the effect of certain tree wound dressings on the rate of healing over of wounds on trees and of the efficacy of the dressings in preventing the development of rot in the wounds. Asphaltum paint was superior to any material tried. In many instances this type of dressing actually enhanced the rate of healing of wounds, and it was more effective than other treatments in sealing wounds so that rots could not develop. At the present time an experiment is under way comparing a large number of wound dressing materials. (Tilford and Young)

EFFECT OF GROWTH SUBSTANCES ON TREE ROOTS

The effect of growth substances, such as indolebutyric, indoleacetic, indolepropionic, and phenylacetic acids on tree root development has been investigated. Seedlings of American elm were root-pruned and treated in January by soaking the roots for 48 hours in solutions which contained 10, 25, and 40 parts per million of the growth substances. American arborvitae, Norway spruce, white pine, hard maple, black oak, pin oak, and black walnut were treated with the four materials at a concentration of 25 parts per million.

After the trees had been grown for 3 months in sand, marked stimulation of new root development was evident on all except white pine and Norway spruce, following treatment with all materials except phenylacetic acid. In most instances indolebutyric acid had the greatest effect. Concentrations of 25 and 40 parts per million were more effective than 10.

When trees growing in soil were watered with these solutions, there was no effect on root development. There was strong stimulation of root development, however, when sphagnum moss was soaked in a solution of indolebutyric acid and then bound on the cut ends of the larger roots of small elms and red oaks. (Tilford)

DAMPING-OFF OF PINE SEEDLINGS

In an experiment at the Marietta nursery for the control of damping-off of red pine, formaldehyde treatments increased the stand of seedlings. On plots treated with ⅛, ¼, and ⅜ ounce of formaldehyde per square foot 3 days before seeding in the fall of 1936, there were 24.7, 39.3, and 55.3 per cent, respectively, more seedlings in the fall of 1937 than on control plots. The results were similar when treatments were made in the spring, previous to spring seeding. The benefit from the treatments this year was that the seed and young seedlings were protected before emergence and that more seedlings emerged on the

treated than on the control plots. After emergence, damping-off was not serious, and the percentage of survival of seedlings at the end of the season was as great on the controls as on the treated plots. (Tilford)

PINE SPRAYING EXPERIMENTS

Scotch, red, Austrian, and Corsican pine seedlings at the Marietta nursery were sprayed during the summer of 1936 with various copper and sulfur fungicidal sprays to determine which mixtures are safe to use on pines, and which are most effective in controlling needle blight. Five different applications were made at approximately 1-month intervals.

No needle blight developed on any of the plots, but some information was obtained on the susceptibility of the different species to spray injury. A 5-2½-50 Bordeaux used with Grasselli Spreader caused slight stunting and injury to the Scotch, Austrian, and red pine seedlings but did not injure Corsican. The 4-4-50 and 5-5-50 mixtures caused no injury on any of the species when used with such spreaders as Casein, Aresket, Nopco Fish Oil, and Grasselli Spreader. Concentrations of liquid lime-sulfur ranging from 2 to 3½ gallons to 100 gallons, used with gelatine as a spreader, caused burning during hot summer weather on all species except Corsican. Likewise, dry lime-sulfur, 8, 12, and 14 pounds to 100 gallons, with gelatine, had the same effect.

In 1937 a block of Corsican pines at the Scioto Trail Forest which had blighted severely in 1936 was sprayed six times in an effort to find materials effective in controlling needle blight, probably caused by a fungus belonging to the genus Septoria[4]. This organism was found more commonly on the blighted needles than any other. Bordeaux mixtures, both a 4-6-50 and a 4-4-50, with Casein and Grasselli Spreader, Bordeaux spray prepared from dry Bordeaux powder, Cupro-K with Grasselli Spreader, and Palustrex were the copper fungicides used. Dry lime-sulfur mixtures (4 pounds to 50 gallons) with gelatine and Grasselli Spreader were also tried. No one of the copper sprays proved superior to any other, but as a group they were slightly better than the lime-sulfur mixtures. The average percentage of needles on the lower branches of trees sprayed with the coppers showing infection at the end of the season was 8.9; whereas 11.1 per cent of the lower needles on trees sprayed with lime-sulfur were infected. Similarly located needles on the unsprayed trees were infected to the extent of 28.0 per cent. None of the materials used as spreaders was significantly better than any other. Plots which received only two applications, one in July and one in August, showed only 10 per cent infection on the lower needles. Evidently infection took place fairly late in the season.

(Tilford)

SIGNIFICANCE OF BACTERIOPHAGE IN ALFALFA CULTURE

The presence of the bacteriophage in stands of alfalfa which have run out or appear to be on the decline raises the question of the importance of the phage factor in connection with this crop. Where the phage occurs nodule formation is absent or very much reduced. Alfalfa seedings 3 years old or older nearly always have the lytic factor present; the same is also true of new seedings in old fields of alfalfa which are no longer productive. Occasionally the phage is found in new seedings of alfalfa upon land where this legume has

[4]The experiment at Scioto Trail Forest was conducted in cooperation with Dr. J. B. Polivka of the E. C. W.

never been grown, or at least not for a period of 5 to 6 years. The phage was not found to be associated with actively growing nodules, yet can commonly be isolated in them in the process of decomposition. The close association of the bacteriophage with many cases of alfalfa failure appears to be more than an incidental occurrence. (Thomas)

THE BACTERIOPHAGE AS AN AID IN IDENTIFICATION OF ISOLATIONS OF BACTERIA

The bacteriophage can be used to advantage in the identification of species of bacterial plant pathogens, also for the differentiation of strains, in the same way that diagnostic serum has been employed for many years. By the use of a bacteriophage specific for *Erwinia amylovora*, identifications have been made of isolations from pear, apple, mountain ash, cotoneaster, and hawthorn. By using lytic principles specific for two different strains of *Aplanobacter stewarti*, quick detection of the strains involved in each case was made. By the use of a bacteriophage associated with alfalfa failure, it is possible to select commercial cultures resistant to the phage for seed inoculation.

Specific phages, after they have been brought to a high titer, may be kept in sealed ampules in a refrigerator for several years. (Thomas)

GLOBELLE: THE NEW LEAF MOLD-RESISTANT TOMATO VARIETY

Previous reports have shown continued progress in the development of a new leaf mold-resistant tomato variety and have shown that the inheritance of resistance is governed by a single dominant Mendelian factor. Sufficient progress has now been made to warrant the introduction of the new variety, Globelle, which closely approaches Globe in type. The development of Globelle has taken 14 generations since the initial cross between the domestic variety Globe, *Lycopersicum esculentum*, and *L. pimpinellifolium*. Four additional crosses to the type varieties Globe and Marhio were necessary. Six generations have elapsed since the last cross. Apparent linkage of the resistant factor with that of small size and a partial lethal has contributed to prolonging the project.

The records available indicate that the new variety, Globelle, will yield as well as, or possibly better than, Globe. The fruits have the same pink color as those of Globe, and the size and quality appear to be slightly superior. Additional records are being taken on yield and quality.

In addition to the development of the pure-breeding resistant variety, Globelle, experiments are under way to investigate the possibilities of additional yield by the use of F_1 generation hybrids. Eighty-one crosses between homozygous resistant selections and Globe have been made, with the object of determining how much increase can be expected and which cross will produce the heaviest yield. (Alexander)

ENTOMOLOGY

BORER CONTROL IN NEWLY SET SHADE TREES

A frequent cause for the death or crippling of newly transplanted shade trees is attack by boring insects. One of the most common species responsible for such losses is the flat-headed apple-tree borer, *Chrysobothris femorata* (Ol).

In the fall of 1935 an experiment was inaugurated in which the State Nurserymen's Association and the Departments of Forestry and Entomology of the Ohio Agricultural Experiment Station cooperated. Slightly more than 2000 trees were involved. Norway maple and elm predominated, although some hard and silver maples were included in the plan.

Treatments were made in the month of May in both 1936 and 1937. These involved a number of liquid materials applied to the entire trunks of the trees by means of paint brushes, also tests of several wrapping materials. None of the paint treatments gave completely satisfactory control, but all of the wrapping treatments afforded almost perfect protection from borer attack. Of the wrappings used, the least expensive and most convenient to apply was double-thickness craft paper of the crepe type with a layer of asphaltum between. This paper was purchased in 4-inch strips wound in bolts containing 25 yards each. Wrapping was started at the base of the tree and spiralled upward with a one-half overlap until the entire trunk was covered. A cord wound spirally in the opposite direction held the wrapping firmly in place.

Beginning the wrap at the base of the tree permits rain water to creep beneath the paper and moisten the bark; this compensates in some measure for the deficiency which exists during the period following transplanting when the roots are not functioning fully.

A secondary beneficial influence from wrapping trees in the manner described is that bruises of the bark and pruning wounds heal more rapidly.

(Houser)

THE BLACK WHEAT-STEM SAWFLY

The black wheat-stem sawfly, *Trachelus tabidus* (Fab.), which was first discovered in eastern Ohio in 1934, has gradually spread westward until it now occupies slightly more than one-fourth the area of the State. The recorded spread to new territory was greater in 1937 than during any previous year.

On the other hand, a slight decrease in intensity of infestation was recorded for the older area of occupancy. Also, the percentage of fallen straw in seriously infested fields was below normal. It is believed that the decrease in straw falling may be attributed, in part at least, to the excess soil moisture at harvest, which in turn may have been responsible for the observed delay of the larvae in their passage downward in the straws, and to the unusually heavy stand of plants in most fields. (Houser)

APPLE FLEA WEEVIL

Previous experiments have demonstrated the efficiency of fluorine compounds in combination with flotation sulfur and a spreader for the control of the apple flea weevil, *Orchestes pallicornis* Say. The schedule followed

involved applications in the prepink and pink periods, from which applications of lime-sulfur were withheld during the interval between the delayed dormant and petal-fall sprays.

Some growers have questioned the advisability of depending solely upon mild sulfurs for scab control during this very critical period and have inquired if supplementary sprays of lime-sulfur might not be applied after one or both of the flea weevil sprays in those years in which the scab menace is particularly threatening. They have inquired also if lime-sulfur might not be substituted for flotation sulfur in the flea weevil formula. One feature of the flea weevil experimental program for 1937 was designed specifically to answer these two questions.

The complete program involved comparisons of three different fluorines used in identical formulas of flotation sulfur and Goulac, the substitution of lime-sulfur for flotation sulfur in one formula, and the substitution of Grasselli Spreader for Goulac in another. In one series of plots, both the prepink and pink applications of fluorine in flotation sulfur and spreader were followed at 2-day intervals with a spray of dry lime-sulfur. One series of plots was sprayed in the prepink and pink periods with lime-sulfur alone.

Subsequent records indicated that apple flea weevil was less abundant this season than for 2 or 3 years previous, and for this reason the data concerning the effect of the several treatments on the control of the insect were not as revealing as could be desired. However, a significant difference in flea weevil control was indicated between all plots sprayed with formulas containing fluorine and the series sprayed with lime-sulfur alone.

The substitution of lime-sulfur for flotation sulfur did not seem to lower the degree of flea weevil control materially; neither did additional sprays of lime-sulfur applied after 2-day intervals following the prepink and pink applications of fluorine. No evidence of burning appeared in any of the plots.

The control of apple scab, which was checked by Dr. H. C. Young, was satisfactory in all plots. (Houser and R. B. Neiswander)

SURVIVAL AND WEIGHT OF EUROPEAN CORN BORER LARVAE FED ON ETIOLATED LEAF TISSUE

Early instar larvae of the European corn borer, *Pyrausta nubilalis* Hubn., feed largely upon etiolated leaf tissue. It appears that differences in larval survival and weight are due either to the differences in the availability of such

TABLE 14.—European Corn Borer Larval Population Prior to Tassel Emergence in Certain Strains Planted at Holgate, Ohio, 1936

Strains	Population per stalk	Strains	Population per stalk
Ohio 67 x Ia. L317	0.7	Ohio 87 (Ohio 67 x Ia. L317)	1.3
Ill. R4 (Ohio 67 x Ia. L317)	0.8	Ind. Tr (Ohio 67 x Ia. L317)	1.4
Ohio 61 (Ohio 67 x Ia. L317)	0.8	Ohio 56 (Ohio 67 x Ia. L317)	1.5
Ill. Hy (Ohio 67 x Ia. L317)	0.9	B.P.I. 540 (Ohio 67 x Ia. L317)	1.7
Ohio 32 (Ohio 67 x Ia. L317)	1.2	Clarage	2.5

tissue or in its nutritive value, or both. It was formerly held that population differences were due primarily to differences in the relative availability of the tassel as larval food. The fact that the tassel remains tightly rolled for a longer period in some strains than in others suggested this possible relationship. This viewpoint has been discarded. Differences in larval survival on a group of strains, prior to the availability of the tassel as food, are shown in Table 14.

In an experiment conducted under laboratory conditions, etiolated leaf tissue of lines Ill. A, Ind. Tr, Ill. Hy, Ill. R_4, and Ia. L317 in top crosses with a common parent was fed to young larvae. The relative availability or abundance of etiolated tissue was not a factor. At the end of nearly 3 weeks of feeding, the larvae that fed upon Ia. L 317 weighed less than one-half as much as those that fed upon line Ill. A. It appears that the relative nutritive value of such leaf tissue may vary with different strains. Further experiments are in progress. (Huber)

CORN RESISTANCE TO SOUTHERN CORN ROOT WORM

Factors other than the damage to roots by the Southern corn root worm, *Diabrotica duodecimpunctata* (Fab.), contribute to the lodging of corn. Obviously, such factors complicate the study of strain resistance. In an investigation now in progress, resistance is defined in terms of the behavior of a strain after as many factors as possible are taken into account. Seasonal maturity of strains, the normal weight and growth habit of root systems, and the weight of infested root systems are among some of the factors considered before a strain is finally evaluated as to its resistance.

The actual root weights of a group of strains, the roots of which had been damaged by root worm larvae are indicated in Table 15. On the basis of mathematically determined relations the weight was estimated from mid-silking dates and percentage of root infestation. It will be noted that the actual root weights of strains containing Ohio 10 x Ind. Tr were lower than expected; whereas the weights of the majority of strains containing Ohio 67 x Ia. L 317 were higher than expected. The latter single cross, as far as this test is concerned, is considered as carrying some degree of resistance.

TABLE 15.—Actual Root Weight and Weight Estimated from Silking and Infestation, on Basis of Mathematically Determined Relations, Holgate, 1936*

Strain	Actual root weight	Estimated root weight	Actual — estimated
Ill. R_4 (Ohio 10 x Ind. Tr)	6	16	—10
Ohio 87 (Ohio 10 x Ind. Tr)	8	14	— 6
B.P.I. 540 (Ohio 10 x Ind. Tr)	11	17	— 6
Ohio 56 (Ohio 10 x Ind. Tr)	9	11	— 2
Ill. Hy (Ohio 10 x Ind. Tr)	13	14	— 1
Ill. R_4 (Ohio 67 x Ia. L317)	12	19	— 7
Ohio 87 (Ohio 67 x Ia. L317)	14	16	— 2
Ohio 56 (Ohio 67 x Ia. L317)	13	13	0
Ill. Hy (Ohio 67 x Ia. L317)	16	14	2
B.P.I. 540 (Ohio 67 x Ia. L317)	31	20	11
(B.P.I. 540 x Ill. Hy) (Ohio 67 x Ia. L317)	32	16	16
(Ohio 56 x B.P.I. 4-8) (Ohio 51 x Ohio 84)	11	11	0
(Os 420 x Os 426) (Cl 447 x L289)	10	6	4

*Strains provided by G. H. Stringfield, Ohio Agricultural Experiment Station and Bureau of Plant Industry.

In this experiment the partial correlation between root weight and per cent of roots infested was —0.674 when the influence of maturity was taken into account. (Huber)

POISON BRAN MASH FOR CUTWORM CONTROL IN CORN

In some instances a poison bran mash made of 5 pounds of bran, 1 quart of S. A. E. 20 oil and ¼ pound of Paris green has been substituted for a mash made of the same materials except that 3 quarts of water and 1 pint of molasses are used instead of oil. Mash made with oil is more easily prepared, will not ferment, and may be stored indefinitely. However, three experiments conducted under controlled conditions in which the dark-sided cutworm, *Euxoa messoria* (Harr.), constituted 95 per cent of the species used indicated that the oil-prepared mash is about 20 per cent less effective than that prepared with water and molasses. Where cutworms had no food other than poisoned mash the water-moistened mixture killed 99 per cent of the worms; whereas the oil mash killed only 79 per cent over a 40-hour period. There is some evidence that the oil-moistened mash is less attractive to the larvae.

One of the treatments included in this series of experiments was a mash made according to the second of the formulas given and afterwards allowed to dry. Obviously, a dry mash has important advantages over a wet mash. After it is dry it can be stored indefinitely. Moreover, cutworm larvae feed as well upon dry as wet mash. There is no practical difference in the effectiveness of the two preparations. A summary of two controlled experiments in which wet and dry mash were compared is presented in Table 16.

TABLE 16.—Comparison of Effectiveness of Wet and Dry Poison Bran Mash in Laboratory Experiments, Wooster, Ohio, 1937

Treatment	Total larvae	Per cent killed
Bran, 5 lb., molasses, 1 pt., water, 3 qt., Paris green, ¼ lb. Wet	95	96
Bran, 5 lb., molasses, 1 pt., water, 3 qt., Paris green, ¼ lb. Dry ...	95	94

(Huber)

ORIENTAL FRUIT MOTH

An unusual type of distribution of damage by oriental fruit moth, *Grapholitha molesta* Busck, appeared in Ohio during the season of 1937, in that in some orchards, peaches ripening at the time of Elberta and Rochester were more heavily infested than were later varieties. It will be recalled that normally the reverse is true.

The damage throughout the State as a whole was variable. In some orchards it declined, but in others losses were more severe than in 1936.

Six colonies of the introduced parasite, *Macrocentrus ancylivorus* Roh., were released in areas where it was not known to be established. These insects were reared at Wooster from fruit moth larvae collected in northern Ohio. This parasite species now appears well established in southwestern as well as northern Ohio. Nine collections of twig-feeding fruit moth larvae were taken in Montgomery County. Sixty-seven per cent of the larvae obtained were parasitized and 95 per cent of the parasitism was due to *Macrocentrus ancylivorus*.

During the 1937 season, 55 colonies representing five species of foreign parasites were received from the Federal Bureau of Entomology and Plant Quarantine. These were released in 40 orchards representing 20 counties of Ohio. Although a period of years will be required to determine the efficiency of these insects, it is encouraging to note that a considerable number of one species was reared this season from a generation of fruit moth larvae which occurred after the original parasite colony was released. (R. B. Neiswander)

THE STRAWBERRY LEAF ROLLER

The strawberry leaf roller, *Ancylis comptana* Froel., again caused damage in southwestern Ohio. Severe injury appeared in Ashland County also. The two common larval parasites which are known to hold the leaf roller in check in certain of the Eastern states are well established in Ohio, but up to the present time have parasitized only a small percentage of the leaf roller larvae.

Ten insecticidal treatments were tested against larvae of the second generation in a planting in Ashland County. Three applications were made at 8-day intervals, beginning July 15, when the first eggs were hatching. Each treatment was replicated five times and another series of five plots was not treated. On August 18, 600 leaflets from each plot were examined and the number showing leaf roller injury was recorded. The data obtained are shown in Table 17.

TABLE 17.—Efficiency of Various Insecticides Measured by the Number of Injured Strawberry Leaflets in a 600-leaflet Sample

Number	Material	Replications					Mean	Per cent of control
		A	B	C	D	E		
1	Kalo, 5 lb..... Grasselli Spreader, 2 oz.. Water, 100 gal.	0	4	40	16	11	14.2	89.3
2	Alorco, 5 lb..... Grasselli Spreader, 2 oz.. Water, 100 gal.....	2	13	9	19	6	9.8	92.6
3	Red Arrow, 2 pt..... Orthol-K, 4 pt..... Water, 100 gal.....	33	33	12	58	34	34.0	74.3
4	Phenothiazine, 3 lb..... Water, 100 gal.....	95	73	42	64	21	59.0	55.4
5	Alorco, 1 part ..... Talc, 2 parts ..... Flour, 2 parts	10	10	16	10	12	11.6	91.2
6	Dry Pyrocide, 1 part.... Talc, 9 parts.....	34	32	16	28	43	30.6	76.9
7	Kalo, 1 part..... Talc, 2 parts ..... Flour, 2 parts	11	6	4	9	6	7.2	94.6
8	Dutox, 1 part..... Talc, 2 parts..... Flour, 2 parts.....	3	16	1	4	8	6.4	95.2
9	Kalo, 3 parts..... Talc, 6 parts.....	5	20	13	8	4	10.0	92.4
10	Kryocide, 1 part ..... Talc, 2 parts..... Flour, 2 parts.....	5	4	10	8	2	5.8	95.6
11	Check (no treatment)...	171	119	82	220	70	132.4	.....

The remainder of the planting, which was not included in the experimental plots and which comprised approximately ¾ acre, was sprayed with the material used in Treatment 1. Counts made on August 18 showed a control of 96 per cent when compared with the untreated plots.

Kalo and Kryocide are commercial forms of natural cryolite, and Alorco is a synthetic cryolite. These materials proved very effective in both the spray and dust forms. Kalo was also used as a spray in 1936 against larvae of the first generation and proved best of 16 insecticidal combinations tested.

(R. B. Neiswander)

THE CODLING MOTH

Seasonal notes.—Overwintered larvae of the codling moth, *Carpocapsa pomonella* Linn., were slightly more abundant than normal in the spring of 1937. Because of cool weather in April and May, moth emergence started and peaked at dates slightly later than usual. In late May and during the month of June, temperatures were just about normal, and this, coupled with good spraying, held the activities of the insect within reasonable limits for most of the State. Only in a few orchards in Lawrence, Ottawa, and Lucas Counties was codling moth damage severe.

Field spray tests.—The testing of possible substitutes for lead arsenate in the spray program constituted a large part of the summer's work. At Wooster, calcium arsenate, zinc arsenate, Phenothiazine, different forms of nicotine, and synthetic cryolite were used in several different schedules compared with lead arsenate. All schedules were applied to at least eight varieties, each with two or more replicated single-tree plots. In no instance did a substitute schedule give better control than lead arsenate, and in several cases programs using Phenothiazine, stabilized nicotines, and synthetic cryolite were distinctly inferior. All of the experimental schedules were started after a calyx spray of lead arsenate.

In the more highly infested area about Gypsum, Ohio, approximately the same materials were used but the schedules differed in that all were started following at least two applications of lead arsenate. The programs of straight lead arsenate and of lead arsenate plus oil were very effective, as was also Black Leaf 40 plus oil in at least three cover sprays. All other materials fell below lead arsenate in efficiency.

Omitting the midsummer spray.—In most sections of Ohio it is the custom to apply one cover spray against second-brood codling moth. This is usually applied during the latter part of July, except in the extreme southern and northeastern parts of the State. In recent years the desire to avoid excess spray residues has led to much discussion of the possibility of omitting this last spray. Tests to determine the feasibility of this point have been conducted during two seasons at Gypsum, Ohio. The results of these tests are shown in Table 18.

From an inspection of Table 18 it is evident that the midsummer spray is of value and must be used to insure good fruit in the more heavily infested areas of Ohio.

Spray injury.—In spraying trees, materials must be used that will control insects and diseases, but it is also essential that these materials be safe for use on foliage and fruit. Many otherwise efficient sprays or spray combinations fail on this account. During the season of 1937, several developments of this character were of interest. In general it may be said that all spreaders and

stickers used with arsenicals gave more injury to foliage than in the usual season. This applied particularly to soybean flour when combined and used in several applications with zinc and calcium arsenate. In some cases up to 40 per cent defoliation developed by September 1 following the use of these combinations.

TABLE 18.—Results of the Omission of the Midsummer Spray, Gypsum, Ohio

	Sprayed in midsummer		Unsprayed in midsummer	
	Number of apples	Worms per 100 apples	Number of apples	Worms per 100 apples
Season of 1936				
Test No. 1	5208	17	6393	37
Test No. 2	7048	22	4822	20
Test No. 3	5551	13	1188	26
Test No. 4	4751	28	3560	33
Test No. 5	3069	7	7504	17
Test No. 6	4811	25	3072	31
Test No. 7	4386	22	8398	42
Test No. 8	2922	20	5280	22
Average worms per 100 apples		19		25
Season of 1937				
Test No. 1	4309	4	3066	12
Test No. 2	4316	2	1932	13
Test No. 3	4439	2	3091	15
Test No. 4	4042	5	5913	10
Test No. 5	4233	5	2554	41
Test No. 6	3312	4	3049	21
Test No. 7	5350	7	3552	8
Test No. 8	2975	3	5881	9
Test No. 9	3656	11	2206	9
Test No. 10	3416	4	3769	6
Test No. 11	2692	12	4171	31
Average worms per 100 apples		5		16

Several of the so-called "safe" calcium arsenates were used and all seemed fully as injurious, if not more so, than the usual types. The most severe damage resulted from the use of two applications in June of a "safe" calcium buffered with zinc sulfate. In this instance, defoliation of the variety Ben Davis amounted to fully 60 per cent. A combination of synthetic cryolite and oil used in three applications in June and July was fairly safe on foliage but injured the fruits of Jonathan, McIntosh, Cortland, and other varieties. This injury was manifest in a dwarfing and distorting of the fruits that detracted greatly from their appearance.

The injuries of the year were predominantly arsenical in character and were undoubtedly due in large part to the cool and humid season. (Cutright)

ONION THRIPS

During the past several years a number of insecticides have been tested in the control of the onion thrips, *Thrips tabaci* Lind. In order that an insecticide be employed commercially in combatting the onion thrips, it must be inexpensive, as well as effective in killing the insect. In view of these prerequisites,

only two of the materials tested appear to offer promise. A mixture of carbon bisulfide and crude chipped naphthalene, prepared by dissolving 2 pounds of crude chipped naphthalene in 3 pints of carbon bisulfide, gave a reduction in population varying from 80 to 90 per cent when used at a dilution of 1 to 163. A pine oil emulsion, used at a concentration of ½ per cent actual oil, gave similar results. At these concentrations no injury to the foliage occurred. However, neither of these materials gave a significant increase in yield over the unsprayed plot. Thrips populations are difficult to reduce permanently; therefore, a number of applications at close intervals are necessary in order to hold the pest in check. (Sleesman)

VARIETAL DIFFERENCES IN POTATO LEAFHOPPER POPULATIONS[5]

Further studies of potato varieties conducted in 1937 confirmed the results of 2 previous years, which had shown that varieties differ to a significant degree in potato leafhopper, *Empoasca fabae* Harris, populations. The correlation between population and maturity was found to be —0.49. This is to say that the early maturing varieties were more heavily populated than the late maturing types.

TABLE 19.—Number of Leafhopper Nymphs per 10 Leaves of Each Variety of Potato

Variety	Population	Days to maturity
Houma	6	100
Jersey Red	13	130
Ohio Late Red	21	130
Green Mountain	21	120
U. S. D. A. 45981	28	100
Columbia Russet	30	100
Giant Hill Rural	30	130
Brown Beauty	33	115
Up-To-Date	35	130
U. S. D. A. 16469	36	130
Early Ohio	36	90
McCormick	51	130
Russet Rural	53	120
Golden	68	100
Chippewa	71	100
Bliss Triumph	74	90
Irish Cobbler	88	90

(Sleesman)

EFFECT OF DIFFERENT COPPER-LIME RATIOS ON THE POTATO LEAFHOPPER

Tests for the control of the potato leafhopper, *Empoasca fabae* Harris, were conducted at McGuffey, Ohio, on muck-grown Irish Cobbler potatoes. Particular emphasis was placed upon the effect of varying the copper-lime ratio in Bordeaux mixture.

The results confirm those of 1936, in that a mixture in which the lime content was reduced to one-half that of the copper sulfate did not inhibit the leafhopper more than did the standard 1 to 1½ copper-lime ratio, but the yield of tubers was significantly higher (Table 20). Varying the formula to apply the

[5]This experiment was conducted in cooperation with John Bushnell, Ohio Agricultural Experiment Station.

greater part of the copper sulfate early in the season also showed to advantage. The addition of a spreading agent to the Bordeaux mixture did not appear to increase the effectiveness of the treatment.

TABLE 20.—Average Yield for the Various Spray Treatments*

	Pounds of copper sulfate applied per acre	Yield in bushels per acre
10-5-50 Bordeaux	150	354
5-5½-50 Bordeaux	150	354
5-5-50 Bordeaux	150	361
5-2½-50 Bordeaux	150	360
5-1¼-50 Bordeaux	150	368
5-2½-50 Bordeaux†	180	378
5-2½-50 Bordeaux	100	332
5-2½-50 Bordeaux	150	360
5-2½-50 Bordeaux	300	403
5-2¼-50 Bordeaux + SS-3, 1-1000	150	359
20-80 copper-lime dust		348
Unsprayed		234

*Six applications of each spray treatment.
†Followed by 10-5-50, 10-5-50, 6-3-50, 3-1½-50, 2-1-50 Bordeaux.

(Sleesman)

BEAN WEEVIL

The activities of the bean weevil, *Acanthoscelides obtectus* (Say), have been studied in the field to determine the effect of time of planting and time of harvesting the crop upon the degree of infestation. Plantings of soup or navy beans were made at weekly intervals from May 18 to July 6, 1936. Harvesting began on August 24 and continued until September 28. The late planted plots were not sufficiently mature to be gathered at the earlier picking dates, but beans from the earliest plantings were included in all pickings.

Infestation was assured by placing in the field pans of infested beans from which weevils were constantly emerging. Thus, the results of this experiment are those which would occur only when a source of infestation was present.

The time of planting appeared to have some influence upon the degree of infestation. It was found that the beans planted early were injured slightly more than those planted later.

More important, however, was the length of time between planting and harvesting. When this interval was short, the beans were less severely damaged than when the period was prolonged.

Under the conditions of this test, beans from mid- to late-season plantings which were harvested as soon as possible were more nearly free from weevil than those planted early or harvested late. (Gui)

CABBAGE WORM CONTROL

Three species of cabbage worms attack cabbage in Ohio. These are *Ascia rapae* (Linn.), *Autographa brassicae* (Riley), and *Plutella maculipennis* Curtis. The research program of 1937 was somewhat similar to that of previous years. The results, however, did not conform, for derris powder—talc dust appeared to protect cabbage to a greater degree than did the other materials used. There were but slight differences in the several plots in the percentage of weight lost by trimming to remove all worm injury from the

head. Distinct differences appear, however, in the yields of the various plots. It is possible that chemical injury to the plants in the plots treated with Paris green and cryolite may account for this variation. A very slight amount of injury was observed in the field on plants sprayed with Paris green.

Three applications of sprays and dusts were made during the season. The dates of these were July 28, August 10, and August 24. The crop was cut between September 26 and October 2. The derris powder used contained 4 per cent of rotenone. In Table 21 the term "gross weight" refers to cabbage trimmed to meet U. S. No. 1 grade, with the exception of the worm injury, which was not removed. The "trimmed weight" is the weight after the worm injury was removed.

TABLE 21.—Performance of Materials Used in Cabbage Worm Control, 1937

Treatment	Gross weight per acre	Trimmed weight per acre	Loss
	Lb.	*Lb.*	*Pct.*
Derris powder.....1 lb. Talc.....7 lb.	31,698	29,857	6
Zinc arsenite.....2 lb. Lime.....2 lb. Grasselli Spreader.....4 oz. Water.....50 gal.	31,289	28,221	10
Dry pyrocide.....1 lb. Talc.....10 lb.	32,311	28,835	11
Derris powder.....1½ lb. Grasselli Spreader.....4 oz. Water.....50 gal.	29,448	26,994	8
Paris green.....2 lb. Grasselli Spreader.....4 oz. Water.....50 gal.	28,835	26,790	7
Paris green.....1 lb. Talc.....10 lb.	28,017	26,585	5
Alorco cryolite.....2 lb. Grasselli Spreader.....4 oz. Water.....50 gal.	27,812	25,151	10
None	26,994	23,722	12

(Gui)

THE ANNUAL WHITE GRUB

The annual white grub, *Ochrosidia villosa* Burm., which has caused so much trouble in the lawns of eastern Ohio during the past few years was again abundant and injurious in 1937.

Inasmuch as the species is strongly attracted to lights, traps were operated in different sections of the State during the flight period, which extends from about June 15 to July 25. In these traps a total of 18,105 beetles was taken, of which 2281 or 12.6 per cent were females. Beetles were taken in all of the traps operated over the eastern half of the State but none were taken in those located in the western half, with the exception of a very few at Mt. Healthy, near Cincinnati. The beetles were particularly abundant at Marietta and Wooster. Reports of injury from the grubs were common over most of eastern Ohio.

The carbon disulfide—rosin fish oil soap emulsion continued to give satisfactory results when applied at the rate of 3 gallons per square yard. Lead arsenate applied at the rate of 10 pounds per 1000 square feet of surface gave a kill of approximately 65 per cent of the grubs in 5 weeks.

(C. R. Neiswander)

GRUB-PROOFING OF SOIL WITH LEAD ARSENATE TREATMENT

In the spring of 1935 a long-time experiment was started at Wooster for measuring the duration of the effectiveness of lead arsenate treatment to lawns in white grub control. The lead arsenate was applied at the time of seeding and was mixed into the upper layer of soil by a light raking. The insecticide was applied at five rates, varying from zero in the checks to 30 pounds per 1000 square feet in the heaviest application. The plots were 10 feet square. Each treatment was replicated eight times with the treatments distributed at random through each of the eight blocks.

Population records were not taken in the fall of 1935 or of 1936 because the Phyllophaga flight was rather light both years. In 1937, however, there was a heavy May beetle flight, and a population record was taken in September of that year. This was done by examining five soil samples in each plot and counting the grubs therein. The results are given in Table 22.

TABLE 22.—White Grubs Recovered from Plots Treated with Lead Arsenate at Varying Rates

Treatment	Rep. 1	Rep. 2	Rep. 3	Rep. 4	Rep. 5	Rep. 6	Rep. 7	Rep. 8	Mean
Check, no insecticide	21	6	8	6	7	3	6	6	2.9
Lead arsenate, 5 lb. per 1000 sq. ft.	0	0	0	0	0	0	0	2	0.3
Lead arsenate, 10 lb. per 1000 sq. ft.	0	0	0	0	0	0	0	0	0.0
Lead arsenate, 20 lb. per 1000 sq. ft.	0	0	0	0	3	0	0	0	0.4
Lead arsenate, 30 lb. per 1000 sq. ft.	0	0	0	0	0	1	1	1	0.4

All insecticide plots had a significantly lower population than the check plots, but the 30-pound rate was apparently no better than the 5-pound rate.

(C. R. Neiswander)

MAY BEETLE SURVEY

During the season of 1937, 11 light traps were in operation at widely separated points over the State in an effort to ascertain the distribution and relative abundance of the different species of Phyllophaga. From these traps 10,001 beetles were taken, with 24 species represented.

The four most abundant species were *P. futilis* (Lec.), with 2846 specimens; *P. rugosa* (Mels.), with 2457 specimens; *P. hirticula* (Knoch.), with 1865 specimens; and *P. fusca* (Froel.), with 1128 specimens. The last three named were taken in every trap operated; whereas the first one, *P. futilis* (Lec.), was taken in all traps but one. The data indicate that these four species were responsible for most of the injury caused by Phyllophaga grubs in Ohio.

The extraordinary flight of beetles this year tends to corroborate a previous indication; namely, that Brood C is probably the most important brood in Ohio. In the eastern part of the State, particularly around Canton, a great many trees, such as walnut, hickory, and oak were defoliated. (C. R. Neiswander)

AN EARWIG ATTACKING RADISHES IN THE GREENHOUSE

In the spring of 1937, a species of earwig, determined by A. B. Gurney of the United States National Museum as *Euborellia annulipes* (Lucas), was found to be very destructive to radishes growing in a greenhouse near Elyria, Ohio. The injury consisted of holes eaten into the radishes, as shown in Figure 3. Such radishes were unmarketable.

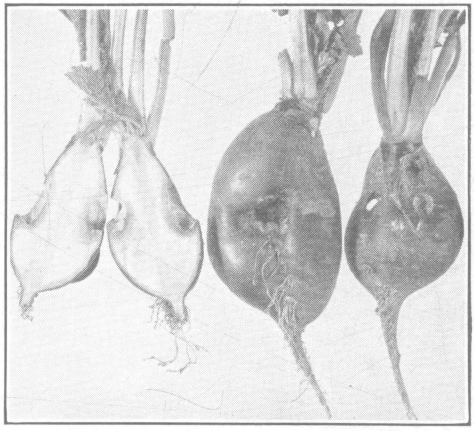

Fig. 3.—Radishes injured by the earwig *Euborellia annulipes* (Lucas)

A poison bait consisting of wheat bran, 16 pounds, Dutox, 1 pound, molasses, 2 quarts, and water, 2 gallons, was found to be very effective. After one application of this material practically all injury ceased and but few live insects could be found. (C. R. Neiswander)

EXTENT OF WINTER LOSSES OF HONEYBEES IN OHIO

Losses of colonies of bees from winterkilling have been recognized as an economic problem among Ohio beekeepers for many years. However, the full import of the problem has not been known because exact data concerning it were not available. A survey, inaugurated in 1935-1936, which is planned to extend over a 5-year period, is expected to correct this deficiency, and at the same time it is hoped that facts will be revealed which may be utilized in avoiding to some degree the continuance of such losses. This report covers the first 2 years of the investigation.

For the winter of 1935-1936, which represents one of the coldest winters on record in Ohio, extremely heavy winter losses occurred among bees. Reports from beekeepers on 11,464 colonies showed that of this number 7,255 were given some form of insulation and that the remaining 4,209 were left unpacked. The packed colonies showed a winter loss of 17 per cent; whereas the unpacked hives had a loss of 35 per cent.

The winter of 1936-1937 was characterized by very mild weather and but slight losses of overwintering bees. In the survey conducted for this winter, reports were obtained on 15,351 colonies, of which 11,334 were packed with a winter loss of 2.6 per cent. Of the 4,017 unpacked colonies there was a loss of 4.5 per cent.

From the combined data of the 2-year period, the winter losses in unpacked colonies were approximately twice those of the packed colonies.

During the second year of the survey, namely, 1936-1937, data were also gathered on the winter losses occurring in packed and unpacked colonies housed in hives of different sizes. Of the unpacked group, 932 colonies were wintered in one-story hives with a loss of 8.5 per cent; 676 colonies, in one and one-half-story hives with a loss of 6.8 per cent; and 1,073 colonies, in two-story hives with a loss of 1.7 per cent. In the group of the packed colonies 3,985 were wintered in one-story hives with a loss of 4.2 per cent; 1,993 colonies, in one and one-half-story hives with a loss of 2 per cent; and 2,819, in two-story hives with a loss of 1.7 per cent. From these data it can be seen that fewer winter losses occurred in the two-story hives characterized by their full-depth food chamber and large quantities of stores. It will be noted that the percentage of loss in the two-story hives was the same in the unpacked and packed groups. This is an interesting coincidence that will bear further careful checking. (Dunham)

HORTICULTURE

POMOLOGY

STUDY OF THE FEMALE SEX CELLS IN APPLE VARIETIES

During the past year special study has been given to the development of the female sex cells in a number of apple varieties. The primary purpose has been to determine the effect of environment upon their development and, in consequence, upon the resulting set of fruit.
The varieties included are:

DIPLOID (34 chromosomes)	TRIPLOID (51 chromosomes)
Delicious	Arkansas
Gallia Beauty	Baldwin
Golden Delicious	Rhode Island Greening
Grimes Golden	Stayman Winesap
Jonathan	Tompkins King
Red Spy	Turley
Winesap	

The principal results to date may be summarized as follows:

1. In the diploid varieties the embryo sacs at the point of opening of the flower invariably contained the full complement of eight nuclei. On the other hand, in the triploid varieties the embryo sacs usually contained only one, two, or at the most four nuclei at the beginning of full bloom. Only rarely was the full complement of eight nuclei present.

2. The stage to which the embryo sacs in the triploid varieties had developed at the opening of the flowers varied from season to season, a fact indicating a definite effect of environment.

3. The embryo sacs developing in opening flowers on cut branches in a warm greenhouse were further advanced than those in flowers opening in the orchard on the same trees from which the branches had been removed.

4. In the Arkansas variety much more abortion of immature embryo sacs occurred in the flowers situated terminally on the cluster base than in those situated laterally and subtended by large leaves. This fact is responsible in cross-pollination tests for the failure of the terminal flowers to set as well as those situated laterally. Furthermore, it has been observed in the orchard that a very large part of the flowers which set fruit in the Arkansas variety are situated laterally on the cluster base.

5. Flowers taken from trees of Stayman Winesap deficient in nitrogen showed a larger amount of abortion of immature embryo sacs than is common in this triploid variety. Nitrogen deficiency thus limits the set of fruit by preventing sufficient embryo sacs from reaching the egg cell stage.

These results, as far as they are concerned with temperature, indicate the manner in which low temperature during bloom may prevent the set of fruit by limiting the number of egg cells produced. Furthermore, they indicate the manner in which the nitrogen supply aids the development of mature embryo sacs and makes satisfactory fruit setting possible. (Howlett)

FIVE NEW APPLE VARIETIES INTRODUCED

During 1937 five new apple varieties were named as a result of the apple breeding program which has been carried on for some years and which at present is receiving considerable attention. The names of these are Franklin, Downing, Warder, Kirtland, and Shaw. All of these varieties are midseason to late in blooming, a characteristic which is receiving predominant attention in the breeding program.

Another aim has been to obtain a variety which is harvested in October and will carry in cold storage until at least January. A brief description of the five new varieties in their approximate order of harvesting is given.

Warder is a Rome Beauty seedling. Its fruit is medium to large, rounded oblate, and almost entirely colored with attractive carmine; its quality is believed to be better than that of Rome Beauty. The time of harvest for Warder is about October 1, and its season is shorter than that of Rome, extending into January in cold storage (35° F.).

Franklin is a seedling of McIntosh pollinated by Delicious. The fruit is of medium size, oblong conic, and well colored with light attractive carmine over a yellow undercolor. The flesh is fine textured, yellow, and has a fine aroma. The quality of Franklin is excellent. Its season of harvest is the first week of October, and its season in cold storage, until January.

Kirtland, a seedling of Ingram, has large, roundish oblong to oblate fruit, very well colored with bright carmine. Kirtland has no resemblance to Ingram. The flesh is juicy, mild, and of distinctly better quality than that of Rome Beauty. Its season of harvest is the second week in October, and it holds well in cold storage until February.

Shaw is a Ralls and Mother seedling with fruit medium to above medium in size and firm. It resembles a well-colored Ralls, with mottled and splashed carmine over a greenish-yellow ground. Its flesh is yellow, firm, crisp, juicy, and of excellent quality. Shaw should be harvested about the third week of October and holds well in cold storage into February.

Downing, a cross between Gallia Beauty and Kirtland, has large, roundish oblate fruit, very well colored with washed carmine over a greenish-yellow ground. Its flesh is juicy, tender, and of better quality than that of Rome. Its harvesting season is about that of Stayman Winesap, and its cold storage season lasts until at least February.

These new varieties have been sent out for trial to several fruit growers, and it is hoped that shortly reports as to their commercial value in Ohio will be received. (Howlett, Gourley, and Ellenwood)

NEW STONE FRUIT VARIETIES

Some new peach varieties which now seem of particular merit are Halehaven, Goldeneast (N. J. No. 87), Welcome, and Cumberland.

Two relatively new sweet cherry varieties which seem outstanding are Victor and Seneca.

Of the plums, the Stanley seems one of the most valuable for Ohio. The Albion is also worthy of trial for a late type. (Havis)

SOME NEW BERRY VARIETIES

During the last season the Catskill strawberry showed special promise as a high yielding and high-quality fruit. The Taylor and Marcy were among the

most outstanding red raspberries, and the Sodus was outstanding among the purples. The Naples and Bristol are worthy of the attention of commercial black raspberry growers of Ohio. (Havis)

POTASH STUDIES IN ORCHARD SOILS

A point of interest in the study of the use of the element potassium in orchards is the finding of large amounts of potassium beneath old mulches where no salts have ever been applied. The Station orchards occupy land which in the main is very low in this element, and when potassic salts are applied the potassium is fixed in the surface few inches of soil and does not move downward into the rooting zone of the trees.

Since the potassium in plant material is largely water-soluble, it became a matter of inquiry whether the leachings of the straw and other mulch materials had accumulated in the surface of the soil where the superficial roots might absorb them. Preliminary "quick tests" were made by using the Thornton method, and they showed that available potassium was very high for 2 to 3 feet beneath the mulch. It was also shown that potassium was present in any considerable amount only in the first few inches of soil beneath the surface in the adjacent 38-year-old bluegrass sod and was notably deficient in the entire cultivated area.

These preliminary tests prompted quantitative determinations in the different areas. The quantitative determinations were made by leaching the soil with normal neutral ammonium acetate and then determining the potassium in the leachate by a standard method[6].

These quantitative results show conclusively that potassium is very high to a depth of from 24 to 32 inches and sometimes to 40 inches beneath the 38-year-old mulch. This is highly significant in light of the characteristic fixation of potash salts in the surface 1½ to 2 inches of surface soil. In no case was potash fertilizer applied to the mulched trees.

Samples of soil taken from the grass area between the trees showed no such accumulation of available potassium. Those taken from an adjacent unfertilized plot which has been in a 3-year rotation of potatoes, wheat, and clover showed a very low potassium content even in the first few inches of topsoil.

Another orchard nearby which has been in the different systems for 22 years shows similar results. The soil under the mulched trees has a high available potassium content to the depth of the rooting area of the trees; whereas the soil under the trees kept in the tillage – cover crop system is very low in this element. For example, the soil beneath two trees in the mulch system has a content of 1000 pounds per acre of available potassium at a depth of 24 inches; whereas the soil beneath a tree 40 feet away in cultivation contains less than 175 pounds at the same depth.

The authors offer no explanation at the present time of the occurrence of the potassium to such a depth beneath the mulch. This finding, however, would indicate that fruit trees grown under the mulch system would not need potash applications, even on soils greatly deficient in potassium.

(Wander and Gourley)

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[6]Bray, R H and F M Willhite Determination of total replaceable bases in soils. Ind. and Eng Chem 1. No 3, p 144, July 15, 1929

Morris, V H and R W. Gerdel. Rapid colorimetric determination of potassium. Plant Phys. 8: 315-319. 1933.

EFFECT OF DECREASING SOIL MOISTURE UPON TREE AND FRUIT GROWTH

During 1936 and 1937 further attention was given to the relationship between soil moisture and fruit growth in the Stayman Winesap apple. Specially designed protective canvases have been used beneath the trees to prevent rainfall from reaching the upper soil layers. Iron strips have been attached end to end and sunk 2½ feet deep, enclosing the soil beneath the tree to this depth in a circle 40 feet in diameter.

In 1936 two of the trees received no rainfall from late May until the middle of November. The moisture was maintained at a high point (field capacity, 23 per cent) in the soil beneath another tree adjacent to those with the protective coverings. Three other trees of the same age (20 years) were also included in the experiment and received rainfall only. Soil moisture samples were taken weekly to a depth of 4 feet beneath the trees. The diameter of the fruit was measured at the same time. Other data, such as stomatal activity of the leaves, were also taken.

The principal results obtained in 1936 are summarized as follows:

1. The rate of fruit growth on the trees which received no rainfall from May 26 until harvest (October 19) was similar to that on the tree which had abundant water.
2. The fruits on the tree in grass mulch and the one in cultivation with cover crop showed growth rates similar to those on the tree receiving the high water supply.
3. The stomatal activity of the leaves of the trees in the dry soil was affected in August; the stomates opened later and closed earlier than those on the trees with normal rainfall and abundant water. However, as indicated above, this was not reflected in a reduced fruit growth rate.
4. The moisture content in the upper foot of soil reached the wilting percentage or range (7.5 per cent) by the time the fruit was picked.
5. The average moisture content of the soil in the upper 4 feet of the dry trees was slightly over 10 per cent at harvest.
6. The moisture content of the fruits was significantly lower on the dry tree than on the tree receiving an abundant water supply.

These results substantiate the conclusion that the Wooster silt loam is a very desirable fruit soil from the moisture viewpoint. Furthermore, they indicate that the surface of the soil may become very dry without consequent reduction in the growth rate of the fruits, provided some roots extend into the deeper soil layers. (Howlett and Bradfield)

THE QUANTITATIVE DETERMINATION OF POTASSIUM IN PLANT TISSUES BY MEANS OF THE SPECTROGRAPH

In a study of the mineral nutrition of plants, the analytical processes often require considerable time and labor. Since potassium is one of the most difficult of the various nutrient elements to determine quantitatively, a method that would give rapid, precise results on potassium would be very helpful.

The apparatus used in making this study was furnished through the courtesy of W. R. Brode of the Department of Chemistry, the Ohio State University.

The material used consisted of apple leaves obtained from three different orchards at the Ohio Agricultural Experiment Station at Wooster, Ohio. These samples were taken from representative trees under different fertilizer treatments and systems of culture. Samples of peach leaves were selected

from trees grown under controlled conditions in sand culture in the greenhouse. One set of trees received a complete nutrient solution; the other received all the necessary elements except potassium.

Corn and hay samples[7] whose potassium contents had already been determined by another method were used to determine the reliability of the spectrographic method.

Results obtained showed that samples taken from trees growing under different fertilizer treatments and cultural systems showed very little difference in potassium content. Data from the analysis of leaves known to be deficient and leaves known to have received a sufficient amount of potassium revealed that a spectrographic method of analysis is applicable to a rapid determination of potassium deficiency. Data obtained from samples that had been analyzed previously by a chemical method showed close agreement with the spectrographic method. The precision was estimated at about 2 to 5 per cent.

The conclusion drawn from the determinations was that the spectrographic method was reliable, rapid, and suited to a routine quantitative analysis of leaf material for the element potassium. (Wander and Gourley)

POROSITY AND ORGANIC MATTER CONTENT OF AN ORCHARD SOIL

The purpose of this test was to secure measurements of the differences in organic matter content and porosity of orchard soils which had been under different cultural systems for a long period of time. The organic matter content of a Wooster silt loam in cultivation, sod, and mulch was determined by the chromic acid method. It was found that the organic matter content was about the same under the mulch and sod but was much lower in the cultivated area (Fig. 4).

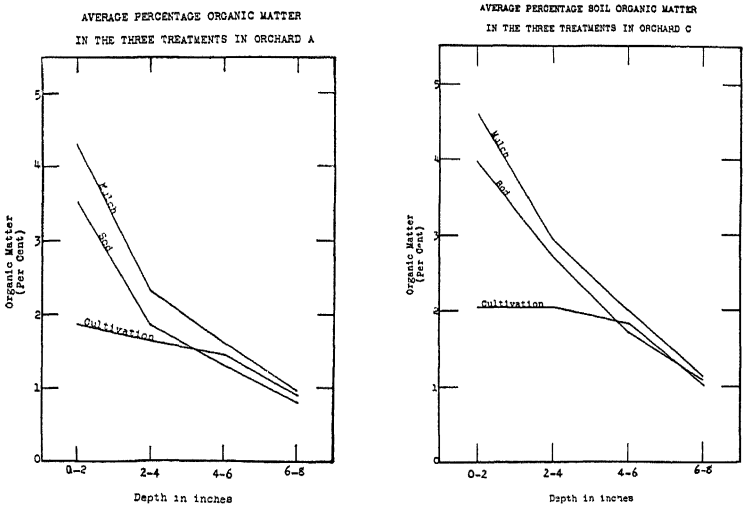


Fig. 4.—Organic matter content of orchard soil in cultivation, sod, and mulch

[7]The corn and hay samples were obtained from the Department of Agronomy through the courtesy of Dr. V. H. Morris.

The porosity of the soil under sod, mulch, and cultivation was obtained by volume-weights and also by rapidity of water absorption. In order of greatest volume-weight and lowest rate of water absorption, the treatments ranked: cultivation, sod, and mulch. (Havis and Gourley)

MULCH PRODUCTION IN ORCHARDS

One of the obstacles to the economic operation of the mulch system in many sections is that of securing adequate mulch material. At least three ways of securing adequate mulch material may be suggested. They are: (1) producing the material between the trees in the orchard, (2) producing the mulch on other areas of the farm to be cut and hauled into the orchard, (3) purchasing straw, hay, or other material for the purpose. The choice depends upon local conditions.

Some tests conducted in 1937 (Table 23) showed that the yield of herbage between the trees could be greatly increased by the use of broadcast applications of nitrogen. Mixed grasses prevailed, but timothy was the chief one. The season was unusually favorable for grass growth.

TABLE 23.—Yield of Mulch Material

Treatment per acre	pH	Lb. of cover crop per acre
Belmont County Experiment Farm		
None	4.95	1573
200 lb. of Cyanamid (samples taken at six points in the orchard)	5.03	3933
	5.20	4689
	5.02	4235
	4.74	4008
	5.48	4311
400 lb. of Cyanamid	5.29	5143
X Orchard, Belmont County		
No treatment	5.83	1361
Wooster		
Plowed, limed, seeded	Pear orchard	5146
Plowed, limed, seeded	Pear orchard	6000
Plowed, limed, seeded	Orchard K	3934
Bluegrass, no fertilizer	Orchard J	1497
Bluegrass, no fertilizer	Orchard A	1926
Apple Creek Sanitarium		
Soil prepared and seeded, 1937	5.5	3630

From these figures it will be seen that the yield of dry hay was increased from 1500 pounds to 2 tons or more per acre. (Gourley and Lewis)

NEWER PROJECTS IN APPLE ORCHARD MANAGEMENT

A number of new projects in fertilization, seeding, production of mulch material, and ways of utilizing such material for the benefit of apple orchards were begun in the spring of 1937 at the Belmont, Clermont, Hamilton, and Mahoning County Experiment Farms, which are situated in fruitgrowing sections of Ohio. These projects really amount to a resumption of experiments in fertilization and mulch production in orchards that were inaugurated in cooperation with orchard owners of southeastern Ohio more than a quarter of a century ago, but have been planned in such a way that their principal features may more nearly conform to present-day trends in apple orchard management.

To those familiar with experiments in comparing plans of soil treatment, it will be obvious that considerable time must elapse before clear-cut, outstanding results of such projects may be set forth in convincing figures or even be visible to a very careful observer of the work itself. (Ballou and Lewis)

SOIL ACIDITY STUDIES IN THE ORCHARD

Determinations by the quinhydrone electrode were made in several orchards on the Station farm and elsewhere in the State. The object was to determine the effect of various fertilizer treatments and cultural methods upon the subsequent soil reaction.

In one test, an orchard which had been mulched heavily for the past 22 years showed pH values which were not significantly different from those of a closely adjacent one which had been cultivated and had cover crops plowed under during the same period of time. The depths at which these determinations were made were 0 to 4 inches, 4 to 8 inches, and 8 to 16 inches.

In another Station orchard, 15 years of age, where sulfate of ammonia has been continuously used, the pH was distinctly lower (pH 4.6 to 4.8) than where calcium cyanamid has been used (6.4 to 7.0). However, there was no difference in appearance or yield of the trees as a result.

In all cases the soil samples were taken beneath the drip of the branches in the area where fertilizer applications had been made.

On a 17-year-old, sod orchard (unmulched) near Salem which has been under different treatments for the past 6 years the use of sulfate of ammonia has resulted in a pH value of approximately 4.2 to 4.4; the use of Cyanamid, in a pH of 5.0 to 6.1.

In these orchards the differences in pH obtained only in the surface 4 inches. Below this depth there was no significant difference.

(Gourley and Allmendinger)

SOIL INVESTIGATIONS WITH STRAWBERRIES

Tests have been conducted to determine the effect of large amounts of organic matter on the growth and production of strawberry plants in the soil at Wooster. In one treatment 15 tons per acre of chopped corn stover were plowed into the soil to a depth of 6 to 8 inches before the plants were set in 1936. The growth of plants in 1936 was very similar in this treatment to that

of plants grown in the usual way and fertilized with 300 pounds of ammonium sulfate. The yield of berries in 1937 was also very similar. The plants rooted to about the same depth in both treatments, but those in the chopped corn stover formed more lateral roots and failed to darken as early in the summer as those in the untreated soil.

In connection with these studies, it was noted that strawberry roots often penetrated to a depth of about 30 inches or to the depth of the glacial drift of sandstone and shale in this Canfield silt loam. It was also found that where plants were set in rows 3½ feet apart, and had formed a matted row 14 to 16 inches wide the roots usually met between the rows. These studies are being continued. (Havis)

RELATIONSHIP OF PLANTING DISTANCE OF APPLE TREES TO PRODUCTION PER ACRE

The proper spacing of apple trees is always an important consideration in planting plans. Data taken from the yield records of certain orchards at the Station throw some light on the acre yields that may be expected from apple orchards planted at different tree spacings.

In the case of Orchard C, the varieties are Stayman and Delicious and the trees are set in squares 35 by 35 feet. In Orchard J, consisting of Baldwin, Wealthy, and Stayman, the spacing is 40 by 20 feet. The permanent trees set in squares of 40 by 40 feet are Stayman and Baldwin. The filler trees set midway between the permanents are Wealthy between Baldwin and Stayman between Stayman permanent trees. In Orchard K the spacing is 38 by 20 feet and the permanent varieties are Jonathan and Stayman with Grimes and McIntosh for filler trees.

Soil conditions in the three orchards are similar with at least average uniformity. It will be noted that the varieties planted in the three orchards differ, but long-time records at the Station show these varieties, with the exception of Wealthy, to be comparable in individual tree yields. As Wealthy is a somewhat smaller tree, the average annual tree yield is generally less than that of the other varieties.

The production per acre of the three orchards is shown in Table 24 for a 6-year period extending from the eleventh to sixteenth years inclusive. At the end of the sixteenth growing season it seemed desirable to remove the filler trees in Orchards J and K. It is doubtful whether the additional production

TABLE 24.—Relationship of Planting Distance to Production per Acre

Age of trees	Orchard C, 35 by 35 feet, Stayman and Delicious	Orchard J, 40 by 20 feet, Baldwin, Stayman, and Wealthy	Orchard K, 38 by 20 feet, Grimes, Jonathan, McIntosh, and Stayman
Yr.	*Bu. per A.*	*Bu. per A.*	*Bu. per A.*
11	190	161	179
12	315	268	240
13	299	181	260
14	115	465	320
15	201	228	307
16	372	566	387
6-year average ...	249	312	282

per acre of Orchards J and K as compared with C would compensate for the added expense of growing and removing the filler trees, since the prevalent selling price of apples in recent years has been low.

(Ellenwood)

THE STORAGE OF FRUIT

In line with the expanding interest among fruit growers in cold storage of fruits on the farm, the Experiment Station has extended its studies on storage of horticultural crops to include tests of forced-air cooling equipment. New air-conditioning equipment consisting of a 3- to 5-ton Freon compressor and finned coils with blower fans was installed in September of 1937 in a 4,000-bushel reinsulated common storage. At the same time a frame building of 4,000-bushel capacity was repaired and insulated with four layers of reflective insulation to be used as a common storage in comparison with the various types of artificially cooled storages already in use.

It is the aim of the investigation to study the condition of fruit varieties held during their storage life under varying conditions of temperature, air movement, relative humidity, and type of container. Storage management and costs, including those for refrigeration, will receive attention because of their important bearing on the economy of refrigeration at the farm with the new forced-air type of equipment. (Comin)

VEGETABLE STUDIES

NEW, HIGH YIELDING VARIETIES OF POTATOES

Among the collection of new varieties sent by the United States Department of Agriculture to the Station for testing were three that excelled the old standard Russet Rural both in yield and general appearance. All three exceeded 400 bushels per acre of marketable potatoes. Samples have been sent to the Department of Home Economics for cooking tests, and the variety of best culinary quality will be rapidly propagated for wider testing and distribution.

A test was also made of named varieties, including the newer introductions and some of the less popular, older varieties. Among the newer varieties, the Warba again outyielded all the older early varieties. In the test at the Washington County Farm the Warba was ready to dig July 10, and produced at the rate of 487 bushels per acre. Among the less known varieties, the Up-to-Date, a very late maturing sort, outyielded the Russet Rural both at Wooster and at the Muck Crops Experiment Farm. The Up-to-Date is not likely to prove popular as a farm crop, because the tubers are very irregular in shape, but it can be recommended as a high yielding garden variety. (Bushnell)

FERTILIZERS IN THE SUBSOIL FOR POTATOES

On most soils potato roots are largely confined to the plowed surface soil; only a few small roots extend into the subsoil. To learn if the addition of ordinary fertilizers or special nutrient salts would increase the depth of rooting, various materials were mixed with the subsoil by hand and potatoes were planted directly above the treated subsoil.

TABLE 25.—Yields of Potatoes Where Fertilizers Were Added to the Subsoil

All plots also fertilized in the usual way at planting with 1000 pounds per acre of 4-8-8

Yield expressed in bushels per acre

Materials added in 1937	Yield	Materials added in 1936	Yield
None, subsoil loosened	233	None	221
Lime	242	Lime	216
Sulfate of ammonia	257	Superphosphate	227
Superphosphate	262	Ammo-phos*	249
Sulfate of ammonia and superphosphate	270	Sulfate of ammonia and superphosphate†	287
Lime, sulfate of ammonia, and superphosphate	279		

*Trade name for ammonium phosphate fertilizer.

†The sulfate of ammonia and superphosphate mixture was in such high concentration in 1936 that it prevented root development in the subsoil, but after the open winter and rainy spring the roots developed abundantly in 1937.

The results show that merely loosening the subsoil does not have any appreciable effect, but that where ammonia or phosphate fertilizers were incorporated the roots occupied the subsoil and the yield of tubers was in most instances increased. Where preliminary tests were made in 1936, potatoes were grown again in 1937. The residual fertilizer gave essentially the same results as were obtained the first year.

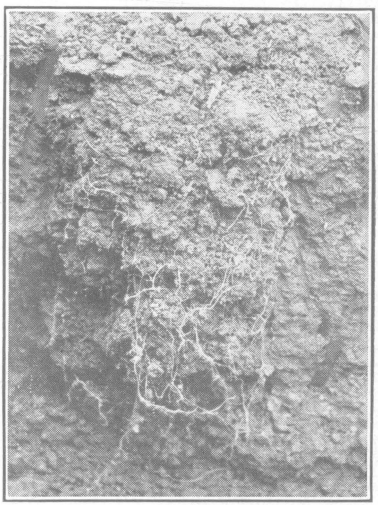


Fig. 5.—Potato roots in the subsoil

The results indicate that the failure of roots to develop extensively in subsoil of the Wooster soil is not due to some toxicity, but is simply due to a deficiency of phosphate and nitrogen. In the tests with chemically pure nutrient salts it was particularly interesting that ammonium salts were more effective than nitrate salts, and that better root development resulted from monoammonium phosphate than from diammonium phosphate. (Bushnell)

TEST OF COBBLER SEED POTATOES PRODUCED IN OHIO

It is well known that early planted potatoes are not suitable for seed the following spring. Consequently, most of the Ohio acreage is planted each year with certified seed shipped from northern states. Several years ago the Station demonstrated that Irish Cobblers planted in June or early July and grown as a summer or fall crop were satisfactory for seed, but it was difficult to get good stands and good yields in these late plantings.

Since then various procedures have been tested to determine a practical method of growing Cobblers as a fall crop. For the past 3 years the following procedure has given reasonably satisfactory results both at Wooster and at the Hamilton County Farm. Certified seed is cut in the ordinary way about the time the sprouts are starting, usually early in May. The cut seed is placed in crates and kept in the cellar storage for 3 days, then moved to a cold storage, preferably at a temperature of 38° F. Sometime in June, when the soil is moist and otherwise in good condition for planting, the seed is removed from storage and planted. After the plants appear, they are sprayed about twice as frequently as ordinary crops. The plants are also rogued to remove those showing any symptoms of disease. By this procedure yields of about 200 bushels per acre have been obtained. This is not an especially high yield but, nevertheless, is profitable because of the high value of good seed Cobblers.

The seed thus produced has been tested at the Washington County Farm in comparison with a number of samples of certified seed from Maine and New York. On the average, the Ohio-grown equalled the certified seed (Table 26). On the basis of these results the Station is advocating the production of Cobbler seed potatoes in Ohio, but is cautioning growers to try it on a small scale because the crop requires extraordinary care.

TABLE 26.—Ohio-grown, Fall-crop Irish Cobblers Compared with Certified, Northern Seed at the Washington County Farm

Source of seed	Yield in bushels per acre of No. 1 grade			
	1935	1936	1937	Average
Certified, northern seed	363	84	363	270
Hamilton County Farm	403	84	346	278
Experiment Station, Wooster	380	102	360	281

(Bushnell)

EVIDENCE OF SIZE LINKAGE WITH THE UNIFORM COLOR GENE IN TOMATOES

The "Uniform Gene" tomato is being used in a breeding program with the object of improving and developing new varieties which will have the uniform ripening character. This tomato is a mutant of the Devon Surprise variety and is homozygous for the recessive gene (u) which controls the even distribution of chlorophyll over the unripe fruit. It tends to ripen uniformly; that is to say, all of the surface of the fruit has approximately the same color during successive stages of ripening. The fruits are small in size, having an average weight of about 51 grams, approximately one-third the weight of commercial varieties.

The F_2 and backcross generations (F_1 backcrossed to "Uniform Gene") of the following crosses were grown at Columbus:

"Uniform Gene" x Marglobe
"Uniform Gene" x Marhio
"Uniform Gene" x Marvel
"Uniform Gene" x Nortan
"Uniform Gene" x Ill. Baltimore
"Uniform Gene" x Louisiana Pink
"Uniform Gene" x Glovel

The progeny of each backcross gave an almost perfect 1:1 segregation ratio of the uniform color versus green stem end fruits. An approximately 3:1 ratio was observed in the F_2 generations. These results are in agreement with the expected ratios which have previously been determined by various plant breeders.

In observing the size of fruits of the uniform color segregates in both the backcross and F_2 generations of all crosses it was noticed that most of the uniform-color fruits were smaller in size than fruits borne on plants of the same population carrying the dominant (U) gene. which is characteristic of the commercial parents. Data were collected which support this statement. From this observation it is thought that a small size factor, or factors, may be linked with the recessive uniform-color gene (u), which is located in the seventh chromosome.

Although this seemed to be the case, there were a few plants in the F_2 generation of each cross that produced uniformly colored fruits that approached the desirable size. These plants were selected and backcrossed to the commercial parents. The apparent linkage of the uniform-color gene (u) with the small size factor, or factors, does not seem to be close enough to exclude the possibilities of obtaining the desirable size and type in advanced generations provided a systematic breeding program is followed. (Brown and Campbell)

PLANT GROWING TESTS

With the aid of funds supplied by canners and through the cooperation of students working on special problems, some progress was made in determining the feasibility of growing tomato plants in cinders and nutrient solutions. Plants made an excellent growth in solutions 1c, 2c, and 3c, as described by Withrow on page 112 of the 1937 Proceedings of the Ohio Vegetable Growers' Association, as long as the solutions were renewed. Growth was satisfactorily checked by failure to renew the solutions or by increasing the concentration of solution 3c to slightly above 3½ atmospheres. The checked plants were eventually grown to maturity in nutrient solution and produced a fair set of fruit.

Hormodin used to accelerate root formation after transplanting was not effective. (Brown and Todd)

IODINE CONTENT OF LETTUCE

The iodine content of leaf lettuce grown in different parts of Ohio varies greatly (see Table 27). The iodine content of Ohio greenhouse lettuce is greater in most instances than that of head lettuce grown in California. The iodine content of leaf lettuce can be increased to nearly 100,000 parts per billion by iodine fertilization (KI).

TABLE 27.—Iodine Content of Leaf Lettuce Grown in Ohio Greenhouses

Area	Dry weight (p. p. b.)	Area	Dry weight (p. p. b.)
Columbus	1,590 2,050 1,420	Toledo	8 940 10,080
Vermilion	6,460 7,680 5,460	Dover	5,460 7,720 6,720
Barberton	12,150 12,510 12,310	Newark	6,210 6,800 6,300
Cincinnati	7,560 7,180 7,980	Ashtabula	4,660 4,480

(Brown and Dietz)

TOMATO VARIETY TESTS, MARIETTA, OHIO

Twenty-nine varieties of tomatoes were included in the tests in 1937. When these varieties were graded on the basis of earliness and yield, Glovel from Stokes ranked first; Break O'Day from Harris, second; Nystate from Harris, third; Bonny Best from Stokes, fourth; and Break O'Day from Livingston, fifth. (Riley and Brown)

CABBAGE VARIETY TESTS AT MARIETTA

Twenty-nine varieties of cabbage were included in the Marietta tests. The most valuable varieties, in the order named, are Resistant Golden Acre (Holmes), Golden Acre Special (Abbott & Cobb), Premiere 802 (Henderson), Copenhagen Market 378 (Hartman), and Early Copenhagen Market (A. Hanson). (Riley and Brown)

SQUASH AND CUCUMBER VARIETY TESTS

Fifteen varieties of so-called summer squash were included in the 1937 variety tests at Columbus. The highest yielding variety was Straightneck from Woodruff; Black Zucchini from Woodruff ranked second; Cocozelle from Woodruff ranked third; and Black Zucchini from Burrell ranked fourth.

Thirty varieties of cucumbers were included in the tests. Chicago Pickling, Longfellow, and Earliest, all from Woodruff, ranked first, second, and third, respectively. A & C from Burrell ranked fourth, and White Wonder from Woodruff, fifth. (Brown and Rahn)

THE EFFECT OF SOME VARIETAL, CULTURAL, HARVESTING, AND STORAGE CONDITIONS UPON THE CONTENT OF CERTAIN MINERAL SALTS AND VITAMINS IN TOMATO FRUITS

The same cooperative arrangement on this project was continued as previously, and more attention was paid to the study of the potency of vitamins A and C than to the mineral analyses. Seventy-five varieties of tomatoes com-

prising a wide selection of white, yellow, orange, pink, and red colors were included in the field trials and two of the pink varieties were raised in the greenhouses under several different conditions.

Vitamin C was determined titrimetrically and verified by biological assay; guinea pigs were again used as the test animals. Vitamin A as carotene was determined spectrophotometrically.

The tomato plants in the greenhouse were trained to single stems and supported on strings in the usual way. Those in the field were also trained to single stems and tied to stakes. They were sprayed four times early in the season with Bordeaux mixture to control certain leaf diseases. Seventy-one of the strains and varieties were tested for vitamin C, and more than 50 were tested for carotene. Rather wide differences were found among the varieties, regardless of color; this confirms the observation of last year that color, by itself, is not associated with vitamin C.

Stage of maturity and acidity were again shown to be closely correlated with vitamin C potency. Many blossoms were tagged in the field as soon as the ovary began to swell, and fruits were picked for pH and vitamin C determinations at 10-, 15-, 20-, 30-day, and ripe intervals. It was again shown that acidity increases steadily during the growing period and increases very rapidly as the fruit approaches full development, but decreases some during the ripening process. Vitamin C is present in small quantity in the very young (10-day) stages and increases as the fruits reach maturity. During the ripening stage it increases much more rapidly, and it reaches its highest content at full ripeness.

Under greenhouse conditions where fertility and moisture could be regulated at will, some striking effects were found. Where the soil moisture was adjusted from dry to very moist, vitamin C was found to be somewhat reduced under the dry conditions. It increased rapidly until enough moisture was supplied that the fruits approached 95 per cent of moisture when fully ripe. As more and more water was applied to the soil the vitamin C content dropped off rapidly even though there was little or no change in the moisture content of the fruits. Vitamin C also tended to increase as the fertility of the soil increased up to what would be considered a high level of fertility (1000 pounds of 0-20-20 per acre, 50 tons of manure, and 200 pounds of calcium nitrate a week for 8 weeks). Much higher rates of application produced practically no change in the vitamin C content.

Different soil types produced little or no change in vitamin C if the level of fertility was high. Different pH levels tended to reduce vitamin C slightly from alkaline to acid conditions when nitrates were supplied, but where ammoniates were used the slight changes did not seem to be characteristic or significant.

Tomato plants which were treated with supplementary electric lights for 2 weeks just before being transferred from 4-inch pots to the growing beds produced fruits of slightly higher vitamin C content than fruits from similar plants not treated with lights. (Hoffman, Krauss, and Washburn)

THE EFFECT OF VERY LARGE APPLICATIONS OF CHEMICAL FERTILIZERS UPON THE GROWTH AND FRUITING OF TOMATOES

As a part of another experiment, data have been secured which show the effect of excessive quantities of chemical fertilizers upon the character of the plants and fruits. Four plots were arranged in the greenhouse so that Plot 1 would have a total application equivalent to that of standard commercial practice (1000 pounds per acre of 0-20-20 when the ground was prepared, and 200 pounds per acre of calcium nitrate at weekly intervals for a period of 8 weeks after the third cluster of fruits was set). All plots had been treated alike previously. Plots 2, 3, and 4 received the amounts in duplicate, triplicate, and quadruplicate, respectively.

TABLE 28.—The Effect of Very Large Quantities of Commercial Fertilizers upon the Number, Size, and Total Weight of Tomato Fruits

Plot No.	Yield per plant				Pounds per square foot	Average number of blossom-end rot fruits per plant
	Average number of fruits set	Average number of fruits marketable	Average weight of fruit	Average weight of each fruit		
			Lb.	*Oz.*		
1	47.91	38.46	12.78	5.31	2.13	9.45*
2	48.85	45.00	13.52	4.80	2.25	3.85
3	43.13	28.43	8.31	4.67	1.38	14.70
4	43.13	30.96	8.31	4.28	1.38	12.22

*Several plants near the south end of the greenhouse developed an unusual number of blossom-end rot fruits during a hot period which raised the average of affected fruits for the lot too high.

The plants in Plot 1 were the tallest and best developed of the lots. They were the darkest green in color and had the largest leaves. The stems were the thickest and the fruits, the largest. Those in Plot 2 were only slightly smaller; whereas those in Plots 3 and 4 were, respectively, smaller in turn.

Table 28 shows that the plants receiving the smaller applications of fertilizer produced larger numbers of fruits of larger size a plant than those receiving higher amounts. The number, size, and total yield per plant decreased with greater concentrations of fertilizers in the soil, and the number of fruits affected with blossom-end rot increased. (Hoffman)

THE EFFECT OF TREATING TOMATO PLANTS WITH ELECTRIC LIGHTS ON THE SET OF EARLY FRUITS

This experiment shows that early tomatoes may be induced to develop more easily when the young plants, still in pots, are illuminated with supplementary electric lights (14-hour day) for 2 to 7 weeks before they are transferred to the growing beds. When treated for 7 weeks during December and January, Marhio plants were able to set fruits on every cluster; whereas those not treated missed the first and part of the second cluster before fruit setting began. Ripe fruits were secured from the lighted plants a week earlier than from the unlighted ones, and they averaged larger throughout the season.

Globe tomato plants treated with lights for 2 weeks preceding transplanting into the growing beds failed to set the first cluster, as did the untreated plants. However, the lighted plants produced a larger number of tomatoes, and these averaged greater total weight for the season than those of the unlighted plants. The gain was more than 11 per cent in marketable fruit. (Hoffman)

FLORICULTURE

A STUDY OF FLOWER BUD DIFFERENTIATION OF CHRYSANTHEMUMS

This study is based on the response of chrysanthemums to variation in the photoperiod. The variety Silver Sheen was grown under normal day length and under a short day length of 10 hours. Daily microchemical studies were made of the growing tip and stem from July 20 to August 12 for the plants receiving the short-day treatment and from July 20 to September 21 for the normal plants. In both cases tests were continued until the flower bud was about ¼ inch in diameter. Anatomical studies showed that the growing point changed from vegetative to a differentiation of the floral primordium within 6 to 8 days after the short-day treatment was begun. Plants shaded between 8 to 20 days showed development of a secondary bud, probably the crown bud. Plants given short-day treatment for 8 days showed greatest development of this bud and lesser developments as the plants were treated for a longer period, so that after 20 days of shading the flowers developed normally.

Microchemical studies indicated that there was very little difference in the protein and ammonium contents of the normal and short-day plants. Reducing sugars were very low to medium in amount at the time of flower bud differentiation in the tip of the plant, and nitrates were absent. This was found in both the plants receiving the short-day treatment and those grown under the normal day length of that season of the year (July to September). In the stem of the plants at the same time reducing sugars varied from very low in the case of the short-day plants to high in the normal plants; nitrates were of a medium amount in the plants grown under both types of treatment. Starch was either entirely absent or present in extremely small amounts in the tip and stem at the time of flower bud initiation. (Link)

CHLOROSIS STUDIES

Chlorosis of pin oaks is caused in many cases by iron deficiency. Tests on it have been under way for the last 4 years. Ferrous sulfate has been applied to chlorotic trees by spraying, injection, and applying to the soil beneath the trees. Previously ferrous sulfate plus sulfur applied in holes in the soil beneath the spread of the branches has given the best results. Applications were made at the rate of ½ pound of each to each inch in diameter of the tree trunk. During the year 1936-1937 the tests were increased to include the use of aluminum sulfate and sulfur as the acidifying agents. Equal quantities of these materials were mixed and applied as above at the rate of ½ pound to each inch in diameter of the tree trunk. In addition, some trees were treated by injecting small amounts, usually 5 grams, of some of the minor elements, magnesium, manganese, zinc, and boron, into the trunks. Little consistency in the tests resulted. The use of aluminum sulfate with the sulfur is promising, as is the injection of manganese sulfate. In general, soils poor in fertility should be treated with a complete commercial fertilizer. Early applications and moisture are essential for satisfactory results. Trees should be treated at the first indication of chlorosis. (Laurie and Chadwick)

EFFECT OF pH AND MINOR ELEMENTS ON THE PRODUCTION OF OUTDOOR ROSES

Plots were adjusted to definite pH's, 6.5 (check), 5.0, 6.0, 7.0, and 8.0. Tests taken weekly or biweekly showed that the plots remained relatively consistent during the course of the experiment. Other plots were given additional amounts (½ to 1 pound per 50 square feet) of boron, magnesium, manganese, and zinc. One plot was mulched with peat moss. Five varieties of roses, six plants of each, were used in each plot. Records were kept during the growing season of the number of blooms cut per plant. Data recorded show the plots ranging as follows (best to poorest, all varieties): zinc, pH 7.0; manganese, pH 5.0; peat moss mulch, pH 6.0; magnesium, pH 8.0; and check. Figures range from 30.4 blooms per plant in the zinc plot to 23.2 in the check plot. The differences between plots are not great in some cases. Further data must be collected before definite conclusions can be drawn. (Laurie and Chadwick)

EFFECT OF GROWTH SUBSTANCES ON ROOT PRODUCTION OF TRANSPLANTED PLANTS

During the winter of 1936-1937 studies were undertaken to determine the feasibility of using some of the growth-promoting substances as aids in stimulating new root growth on the roots of ornamental shrubs.

Three-year, field-grown seedlings of *Viburnum dilatatum* and *Cotoneaster divaricata* were removed from the field on February 6 and 16, respectively, washed, root-pruned severely, and potted in 5-inch pots in loam soil of an acid reaction (pH 6.0), high in nitrate nitrogen and potassium but relatively low in phosphorus. After the plants were treated with the growth substances they were placed in a cool greenhouse.

The growth substances used in these tests were indoleacetic, indolebutyric, and phenylacetic acids. Applications were made (a) by soaking the roots in solutions of 2 milligrams, 5 milligrams (Cotoneaster only), and 10 milligrams per 100 cubic centimeters for 18 hours, (b) by applying 100 cubic centimeters of solution containing 10 milligrams and 20 milligrams of the acids to the soil after potting, and (c) by coating the roots of the plant with emulsified paraffin containing the growth substances. This latter method of treatment was used only with *Viburnum dilatatum*, and in general, such treatments were unsatisfactory.

With *Viburnum dilatatum* soaking the roots 18 hours in 2 milligrams per 100 cubic centimeters of indolebutyric acid gave the best results. Masses of new roots appeared near the end of the old roots where they were cut. Of the soil treatments the application of 20 milligrams per 100 cubic centimeters of indoleacetic acid proved the most satisfactory.

The results with *Cotoneaster divaricata* were similar. Soaking the roots in indolebutyric acid, 5 milligrams per 100 cubic centimeters, for 18 hours proved the most satisfactory treatment.

These preliminary experiments showed that considerable root stimulation could be expected from soaking the roots of the deciduous shrubs used in some of the growth substances. Applications to the soil after potting may be useful under some conditions. More work needs to be done, especially in regard to practical commercial applications, before definite conclusions can be drawn. (Laurie and Chadwick)

ASTERS FOR A SPRING CROP

The following tests will indicate the possibility of growing a crop of asters for early May. Seed was sown November 15, and the plants were set out December 29. Additional light from 40-watt lamps spaced 4 feet apart was given for 4 hours daily.

TABLE 29.—Effect of Additional Light on the Growth and Flowering of Asters

Crop	Date of first cut	Average number of flowers per plant	Average stem length (inches)	Average diameter of flower (inches)
Plot 1, lighted from potting to blooming, 60° F. bottom heat				
Queen of the Market Light Blue	May 5	8.0	9.0	2.75
Imbricated Pompon Rose	May 8	14.9	7.0	1.25
Giant Crego Blue Flame	May 12	5.5	15.0	3.40
Giant Branching White	May 25	7.3	14.8	3.10
Royal Shell Pink	May 26	7.0	13.2	2.90
Balls White	May 25	7.5	18.0	3.25
Plot 2, lighted from potting to blooming				
Queen of the Market Light Blue	May 12	6.5	12.5	3.10
Imbricated Pompon Rose	May 12	11.1	8.0	2.25
Giant Crego Blue Flame	May 12	4.1	14.2	4.00
Giant Branching White	May 25	7.0	19.8	3.12
Royal Shell Pink	May 28	6.7	12.1	3.08
Balls White	June 4*	0.5	22.0	3.00
Plot 3, lighted from benching to blooming				
Queen of the Market Light Blue	May 12	14.3	21.7	2.80
Imbricated Pompon Rose	May 26	9.8	9.6	1.30
Giant Crego Blue Flame	May 12	7.3	14.7	3.90
Giant Branching White	May 28	7.4	17.5	3.25
Royal Shell Pink	May 28	6.0	14.0	3.30
Balls White	May 28	6.3	17.6	3.00
Plot 4, no light				
Queen of the Market Light Blue	May 28		12	2
Imbricated Pompon Rose	June 4		9	
The other varieties were in the rosette state June 4, and probably would bloom in July				

*First cut only.

It will be seen that considerable earliness results from the plots' receiving additional light. Where bottom heat was used a slight earliness resulted. There is no appreciable difference in time whether the plants are lighted from the seedling stage or from the time of benching. The cost of growing the crop with additional light is small. (Poesch)

ARTIFICIAL MANURE

The following test illustrates how quickly manure can be made from straw.

1. Straw, 2000 lb. + { 70 lb. of ammonium sulfate, 30 lb. of superphosphate, 50 lb. of ground limestone } made 3000 lb. of manure
2. Straw, 2000 lb. + potassium permanganate, 1 lb. to 50 gal. of water made 3500 lb. of manure
3. Straw, 2000 lb. + { 150 lb. of Cyanamid, 15 lb. of superphosphate } made 3400 lb. of manure

Under the favorable conditions of moisture in the early summer complete decomposition took place in 6 weeks. (Laurie)

USE OF PHOSPHORUS TO LIMIT HEIGHT OF LILIES

Because of the tendency in many cases to get lilies too tall for pot use, tests were made to determine the means by which the height could be limited. It was found first that reduction of humidity in the air, as well as the amount of water at the roots, was conducive to shortening the stems. Temperature likewise plays its part.

Secondly, it was thought that additions of phosphorus in the soluble state to the soil at the time of potting or later might aid materially in attaining the same end. The results of this test are given in Table 30.

TABLE 30.—Effect of Additions of Soluble Phosphorus on the Stem Length and Number of Flowers per Stem

	Stem length	Average number of flowers per stem
Lilium giganteum	*In.*	*In.*
Monobasic sodium phosphate		
1 ounce in 1 gallon biweekly	19.4	3.5
1 ounce in 1 gallon weekly	20.5	4.1
1 ounce in 2 gallons biweekly	23.1	3.9
1 ounce in 2 gallons weekly	22.1	4.1
Check—low phosphorus	23.2	3.1

We get a slight decrease in stem length with stronger applications of this soluble phosphorus without any appreciable reduction in number of flowers.

TABLE 31.—Effect of Superphosphate Applications on Stem Length and Number of Flowers per Plant

	Stem length	Average number of flowers per stem
Lilium giganteum erabu	*In.*	
4-in. pot of superphosphate to bu. of soil	15.5	3.3
3-in. pot of superphosphate to bu. of soil	17.0	3.4
2-in. pot of superphosphate to bu. of soil	20.7	4.2
1-in. pot of superphosphate to bu. of soil	23.3	4.2
Check, soil low in phosphorus	26.8	4.5

This test, with commercial 20 per cent superphosphate, indicates considerable difference in stem length. It should be noted that a very high amount (4-inch pot to bushel) has a tendency to decrease the number of flowers per stem. The recommendation to be made from these tests is that in soils which lack phosphorus or are low in this element, a 3-inch pot to a bushel will give a sufficient stem length reduction to warrant its use. (Laurie)

CHEMICALS USED TO PROMOTE ROOTING OF CUTTINGS

During the past year tests were made with various organic compounds known as growth-promoting substances. The purpose was to secure, by vegetative propagation, better rooted cuttings, a higher percentage of rooting, rooting of cuttings which normally cannot be rooted, and rooting in a shorter period of time. The organic compounds used as growth-promoting substances were indolebutyric acid, indoleacetic acid, phenolacetic acid, indolepropionic acid, methyl-indolepropionate, and naphthaleneacetic acid.

TABLE 32.—The Effect of Growth-promoting Substances on Rooting

Plant	Time	Substance	Best concentration	Best length of treatment	Time of rooting	Percentage of rooting
				Hr.	*Days*	
Boston Yellow Daisy	Apr. 18	Indolebutyric	5 mg. in 100 cc.	3	10	100
Check	Apr. 18				10	25
Bouvardia humboldti	Mar. 6	Indolebutyric	1 mg. in 100 cc.	18	27	96
Check	Mar. 6				27	64
Carnation var. White Matchless	Mar. 6	Indolebutyric	3 mg. in 100 cc.	3	11	100
Check	Mar. 6				17	58
Chrysanthemum segetum	Mar. 6	Indolebutyric	1 mg. in 100 cc.	18	10	100
Check	Mar. 6				10	8
Chrysanthemum Dorothy Turner	Mar. 6	Indolebutyric	5 mg. in 100 cc.	3	14	96
Check	Mar. 6				14	12
Chrysanthemum Snow White	Apr. 3	Indolebutyric	5 mg. in 100 cc.	3	11	100
Check	Apr. 3				18	65
Euonymus japonica variegata	Feb. 2	Indolebutyric	5 mg. in 100 cc.	18	25	100
Check	Feb. 2				51	56
Felicia amelloides	Apr. 2	Indolebutyric	5 mg. in 100 cc.	1	10	100
Check	Apr. 2				10	0
Genista	Feb. 2	Naphthaleneacetic	5 mg. in 100 cc.	8	46	100
Check	Feb. 2				46	60
Gardenia	Mar. 16	Indolebutyric	5 mg. in 100 cc.	24	30	100
Check	Mar. 16				30	56
Geranium var. Columbus	Mar. 2	Indolebutyric	3 mg. in 100 cc.	3	21	100
Check	Mar. 2				21	76
Geranium var. Lawrence	Apr. 2	Indolebutyric	5 mg. in 100 cc.	1	11	100
Check	Apr. 2				11	0
Hydrangea Europa	Feb. 12	Indolebutyric	3 mg. in 100 cc.	18	23	100
Check	Feb. 12				26	100
Hydrangea Kunert	Feb. 12	Indolebutyric	3 mg. in 100 cc.	18	23	100
Check	Feb. 12				26	100
Hydrangea Gertrude Glahn	Feb. 26	Indolebutyric	3 mg. in 100 cc.	18	15	100
Check	Feb. 26				20	80
Jasmine	Feb. 2	Indoleacetic	5 mg. in 100 cc.	8	32	100
Check	Feb. 2				42	80
Labonia floribunda	Feb. 2	Indolebutyric	5 mg. in 100 cc.	8	20	100
Check	Feb. 2				32	50
Lantana var. M. Schmidt	Apr. 2	Indolebutyric	5 mg. in 100 cc.	1	10	100
Check	Apr. 2				16	92
Oleander	Feb. 2	Indolebutyric	5 mg. in 100 cc.	8	32	100
Check	Feb. 2				32	0
Rochea	Mar. 17	Indolebutyric	3 mg. in 100 cc.	1	10	100
Check	Mar. 17				18	80
Rose Better Times	Apr. 3	Indolebutyric	3 mg. in 100 cc.	6	17	60
Check	Apr. 3				17	0 (All callused)

The organic acids were secured in crystalline form. The stock solution was made up at the rate of 4 milligrams of the acid to 1 cubic centimeter of 50 per cent ethyl alcohol. Further dilutions were made when needed from this stock solution.

The desired solutions were placed in 1000-cubic centimeter beakers to a depth of approximately 1 inch. An equal number of cuttings were bunched, with the basal ends even, and placed in each solution for the desired length of time. The checks consisted of placing the cuttings in distilled water for the same length of time as those treated. The cuttings were placed directly in sand without being washed with water.

Table 32 indicates the differences in rooting with and without growth-promoting substances.

(Poesch)

LIGHT ON GARDENIAS

The use of additional light is worth while on gardenias to produce earliness of flowering. One-hundred-watt lamps spaced 5 feet apart should be placed over one bench, 150-watt lamps in an aisle between two benches. The light should be turned on about September 15 for 6 hours each day at dusk and carried on until about the middle of February. Approximately 20 foot-candles of intensity should be had at the point farthest away from the source of light. The results in Table 33 show that for early cutting light is beneficial, but that after the days get longer, the unlighted plants catch up and the total cut for the year is similar. Bud drop is reduced somewhat under light during the dark months.

TABLE 33.—Gardenia Veitchii. Benched in May, Started Cutting October 24

Treatment	Flowers per plant	Bud drop per plant
Recorded to Christmas		
Lighted	5	5
Unlighted	1	7
From Christmas to Easter		
Lighted	19	10
Unlighted	20	10

(Poesch)

CLOTH HOUSE

Asters grown in a cloth house will respond to shading the same as Chrysanthemums and come into bloom earlier than those grown normally. Plants that were shaded flowered 10 to 15 days earlier than normal. In most varieties used in this test the stem length was shorter, and the flower diameter was slightly smaller than in those not shaded. The plants, either those shaded or those not shaded, were not disbudded in any case. If the shading of asters is to be practiced, the flower stems should be disbudded to one flower. This will produce flowers of a normal size and stem length.

Two different tests were conducted on chrysanthemums in the cloth house. The first of these tests was to determine the proper distance of spacing of pom-

pons grown under cloth and shaded. Four varieties were used, Ethel, Irene, Jewel, and Varsity. These were grown in ground beds and spaced 7 by 8, 8 by 9, 9 by 9, and 12 by 12 inches

This test was a continuation of a similar one carried on during the summer of 1935. The results obtained during 2 years, although they varied slightly, indicate that a planting distance of 8 by 9 inches gives the best production per square foot. Planting at a greater distance produces a large number of stems and these are often much weaker with many small side shoots. In general, a pompon chrysanthemum will give the best flowers with not more than 6 or 7 stems per plant.

The second test with pompons under cloth was an attempt to correlate the date of the last pinch and production under a reduced daylight period. These plants were planted and cared for as those in the preceding experiment. They were planted 8 by 9 inches and shaded from July 10 to September 15. The conclusions from 2 years' work indicate that pinching 1 week before reducing the photoperiod is safe for satisfactory production and quality. (Link)

ECONOMIC SURVEYS

Three different surveys were conducted to determine the present practices of wholesale commission houses and retail flower stores, and the consumer interest in flowers. The following consumer reactions are significant:

1. Window display advertising is more important than newspaper, direct mail, magazine, radio, or billboard advertising.
2. Pricing of merchandise is advisable.
3. Advertising of flowers for funerals is not objectionable.
4. High-toned shops are objectionable.
5. Greenhouses adjacent to shops are desirable.
6. Special sales are questionable.
7. Freshness, price, and quality, in the order named, are the factors used in choosing flowers.
8. Flowers are not a luxury. (Laurie)

KEEPING QUALITIES OF CUT FLOWERS

The results of last year's tests on the keeping qualities of cut flowers may be summarized as follows.

1. Plants may aid in increasing humidity in the home when outdoor moisture is low.
2. Cushioning of the soil balls of hydrangeas and cinerarias is a worthwhile practice.
3. Forty to 50° F. is the most suitable temperature for refrigeration.
4. Humidity should be between 50 and 80 per cent; the latter is preferable.
5. Cut flowers keep as well in shallow containers as in deep. In case of roses, it should be noted that when these are taken out of the cooler and arranged at once they will keep as well in shallow as in deep water, but if the roses are boxed and kept dry for several hours before use, even though the stems are cut, they should be immersed in deep water first for some time to soften up the shriveling tissues.
6. Reduction of stem length increases keeping qualities.

7. Placement of flowers in water after cutting is desirable.

8. Stems should be cut daily and the water should be changed.

9. There is no advantage in cutting stems under water if the stems are cut daily and the water is changed.

10. Crushing of stems of chrysanthemums and stocks is advisable.

11. Immersion of poinsettia, poppy, and heliotrope stems in boiling water before placement in water is necessary. Dahlia is not affected unless wilted.

12. Copper containers as a rule are not beneficial in prolonging the keeping qualities of cut flowers.

13. Except for hydrozene sulfate, 1 milligram to 100 cubic centimeters, most chemicals do not help in keeping flowers.

14. Disinfectants used to cleanse containers and kill bacteria are worth while.

15. Ballooning of flowers for sprays keeps the sprays in a fresh condition much longer.

16. Cellophane bags are useful in prolonging the keeping qualities of made-up work before delivery.

17. Wire used for fillers in baskets is better than evergreens or trash.

18. Parafilm helps to keep flowers in corsages somewhat longer.

19. The use of moist cotton about the bases and sides of cut flowers and a further covering with parafilm makes corsage flowers keep much better.

20. Keeping of packaged flowers in a warm room before delivery reduces their keeping quality. The longer they are kept under such conditions the shorter their life. (Laurie)

HOT WATER VERSUS STEAM STERILIZATION OF SWEET PEA SOIL

To determine the usefulness of these two methods of soil treatment, tests were started in 1935 and continued for 2 years. It was found that untreated soil and steam-sterilized soil produced poorer crops, the former because of losses due to damping-off fungus and shorter stems, the latter because of shortness of stem. Steam-sterilized and leached soil compared favorably with hot water treated; both produced longer stemmed flowers. Because of the greater ease of operation and the possibility of almost immediate planting after sterilization and leaching, the steam sterilization method is to be preferred to hot water treatment. Soil tests conducted by the Department of Agronomy indicated that soluble salts, ammonia nitrogen, and nitrate nitrogen, were present in higher amounts in steam-sterilized plots which were not leached than in those which were leached or treated with hot water. These tests correlate directly with the results in production and indicate that high soluble salts, particularly nitrates, are detrimental to the growth of sweet peas in ground beds. (Laurie and Simon)

DAIRY INDUSTRY

PALATABILITY OF SOYBEAN OIL MEALS

A free choice method of feeding is being used to test the palatability of three common types of soybean oil meal available on the market. The types may be classified according to the method of their production, and include hydraulic, extracted, and expeller process meals. These feeds are used as protein supplements in grain mixtures which differ only in the type of soybean oil meal present. The individual mixtures are placed in buckets held in a rack, and a cow is given an opportunity to eat as she chooses for a limited time. (See Fig. 6).

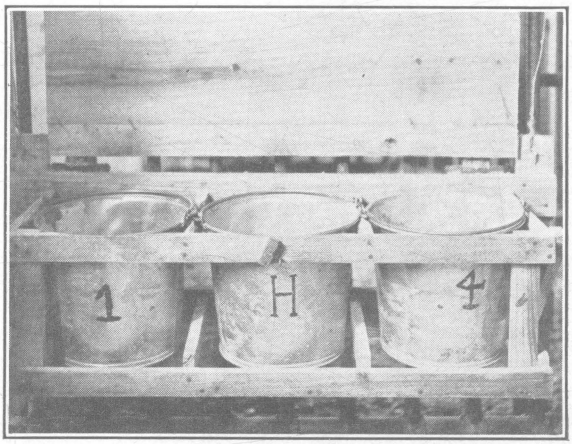


Fig. 6.—Rack in which the different soybean oil meal – grain mixtures were offered to the cows

This work is still in progress. The results thus far indicate that a cow's initial preference may change and that she may learn to like feeds. Not all the cows have shown the same preferences. In general, the results to date indicate that any one of the meals used in this work may be fed without encountering any palatability difficulty. (Monroe)

PEAS, OATS, AND FLAX FOR COWS[8]

The second year's feeding test with a mixture of peas, flaxseed, and oats has been completed. This mixture represented the grain resulting from growing, harvesting, and threshing these crops together. The composition of the mixture was very similar to that of the first year, but there were fewer weed seeds in the crop of 1936. The percentage composition of the harvested grain was 21.6 per cent peas, 5.3 per cent flaxseed, 63.2 per cent oats, 9.7 per cent oat hulls and other light material. This combination of grains analyzed 17.8 per cent protein.

[8]In cooperation with the Department of Agronomy.

The mixture was apparently very palatable and no difficulty was encountered in getting the cows to eat it. In a special palatability test the cows ate practically as much of this feed as of a standard check ration composed of corn, oats, bran, and linseed oil meal. In the test on the previous crop the combination of peas, flaxseed, and oats was found to be less palatable than the check ration. This difference in palatability of the combination mixture may have been due to a difference in the weed seeds contained in the 2 years' crops.

In the 1936 crop, the percentage of weed seeds was very small, but the crop of 1934 was almost 10 per cent lambsquarters seeds.

The results of a feeding trial in which the home-grown mixture was compared with a standard grain ration are shown in Table 34.

TABLE 34.—Average Production per Month, Gains, and Feed Consumption

Ration	Milk	Fat	Fat	Four per cent milk	Live weight gain	Grain	Hay
	Lb.	*Pct.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Peas, flax, oats.....	680.4	4.58	31.2	740.1	15	263	564
Check	681.6	4.47	30.5	730.9	10	268	562

(Monroe and Thatcher)

A METHOD FOR MEASURING THE LOSS OF JUICE AND VOLUME-WEIGHT RELATIONSHIP AT DIFFERENT PRESSURES OF ENSILED CROPS

Figure 7 shows an apparatus which has been developed for measuring the loss of juice that may be expected at stated pressures within the silo when crops having various degrees of dry-matter content are ensiled. Some data regarding this work are presented in the Bimonthly Bulletin for January-February, 1938. The data given in Table 35 illustrate another use of this equipment. The volume occupied by the silage under stated conditions is readily calculated from the position of the plunger at the close of the experimental period and the cross-sectional area of the cylinder. The silage is weighed as it is removed from the apparatus. The weight in grams divided by the volume in cubic centimeters gives a practical measure of the specific gravity of the silage.

TABLE 35.—Data Regarding Pressure, Loss of Juice, and Volume-weight Relationship of Certain Samples of Silage

Crop	Date, 1937	Air-dry matter	Pressure per square inch	Loss of juice	Final weight	Final volume	Specific gravity
		Pct.	*Lb.*	*Cc.*	*Gr.*	*Cc.*	
Corn.....	Aug. 2	17	12	1090	2720	3106	0.875
Corn.....	Aug. 10	17	12	980	2665	2998	0.889
Corn.....	Aug. 10	17	8	800	2843	3270	0.867
Corn.....	Aug. 18	17	12	870	2959	3350	0.883
Corn..... ...	Aug. 30	21	10	250	3525	4006	0.880
Corn...	Sept. 10	26	16	660	3172	3659	0.867
Corn..... ...	Sept. 10	26	12	410	3417	3843	0.889
Corn.....	Sept. 22	32	16	none	3095	4117	0.751
Corn.	Sept. 22	32	12	none	3106	4536	0.685
Alfalfa (wet with dew) ..	July 29	23	8	760	3116	3371	0.924

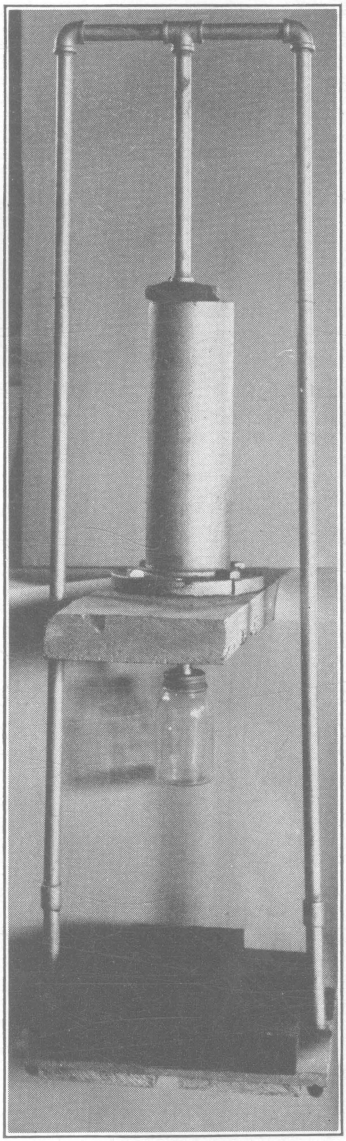


Fig. 7.—Apparatus used in pressure tests

The specific gravity of corn silage made under conditions which result in some loss of juice shows a remarkable degree of constancy, ranging from 0.867 to 0.889, irrespective of the weight employed or the volume of juice lost. Corn silage made from a sample of more mature corn at two different pressures with no loss of juice shows decidedly lower but different values for the specific gravity, depending upon the pressure applied. A single sample of alfalfa silage on which the complete data are available shows a decidedly higher specific gravity than any of the corn samples. This observation is in line with the greater tonnage capacity of silos for green hay crops than for corn.

(Perkins)

CORN-SOYBEAN SILAGE VERSUS ALFALFA HAY AND CORN SILAGE

A silage composed of equal parts of corn and soybeans was fed to a group of cows as the only roughage in comparison with a standard roughage ration composed of alfalfa hay and corn silage. Eighteen cows divided into two groups were used in this test. The groups were alternated in 60-day periods on the two roughage rations previously mentioned. The same grain mixture was fed to both groups throughout the test. The results of this trial are summarized in Table 36.

TABLE 36.—Average Production per Cow per Month on Alfalfa Hay and Corn Silage and on Corn-soybean Silage Rations

Ration	Milk	Fat	Fat	Four per cent milk	Live weight gain	Grain	Hay	Corn silage	Corn-soybean silage	Dry-matter intake	Milk per pound of dry-matter intake
	Lb.	*Pct.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Alfalfa hay and corn silage.....	920.1	4.25	39.1	954.1	11.0	264	349	1043	.....	872	1.094
Corn-soybean silage.....	842.4	4.36	36.7	887.3	−5.5	257	.....	.....	1817	821	1.080
Difference.....	77.7	-0.11	2.4	66.8	16.5	7	.....	.....	.....	51	0.014

Although the cows on the corn-soybean silage were given all of this material they would eat, the dry-matter intake on this ration was not as great as that on the check ration. This lower intake probably explains why the milk production and live weight gains were less on the corn-soybean silage ration than on the standard ration. However, when the results are figured on the basis of dry-matter intake, the rations were very nearly equal. The quality of the bean crop may have influenced the intake. The soybeans contained approximately 50 per cent of weeds, mostly lambsquarters and redroot. This is a condition that is apt to occur in some years. Putting such a crop into the silo with corn is a means of utilizing it.

It was hoped that the natural acidity of the corn silage would preserve the carotene in the soybeans. This was not the case, however, because on a dry-matter basis the corn-soybean silage contained 64.7 parts of carotene per million; whereas corn silage alone contained 72.0 parts per million. Confirmation of these values was obtained indirectly by determining the carotene content of the butterfat of each cow at the beginning and at the end of each period.

(Hayden, Monroe, Krauss, and Perkins)

LOSS OF CAROTENE IN HAYMAKING

The effect of weather on the loss of carotene in haymaking is shown in Table 37.

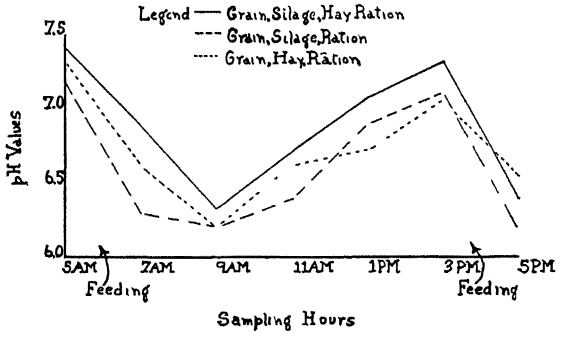
TABLE 37.—Loss of Carotene in Haymaking

	Dry matter Pct.	Carotene P. p. m.	Loss Pct.
First cutting			
Green alfalfa, in field, June 8, 1937	18.0	219	.....
Cut June 8 and put in windrows; part cocked next day:			
June 9 Windrow	41.0	139	36.6
Cock	39.0	125	42.9
June 10 Windrow (rain)	24.7	113	48.5
Cock	19.6	120	45.1
June 14 Windrow (2 good drying days)	55.5	42	80.8
Cock	49.0	59	73.3
June 16 Windrow	66.8	28	87.1
Cock	63.6	37	83.2
Second cutting			
Green alfalfa, in field, July 20, 1937	25.0	154	.....
Cut July 21, cured in windrows (excellent drying weather)			
Brought in as hay, July 22	79.2	68	55.8

(Krauss and Washburn)

A STUDY OF THE HYDROGEN-ION CONCENTRATION OF THE CONTENTS OF THE BOVINE RUMEN

In continuation of this study samples have been taken from the rumen of a cow through a fistula at intervals of 2 hours during the day. This study reveals that there are very marked changes in the pH value of rumen contents during the day.



pH Values of Paunch Contents During the Day on Different Rations

Fig. 8

On the rations studied there was an acid trend after feeding which reached the maximum from 3 to 4 hours after feeding. After this maximum had been reached there was a turn toward alkalinity, which reached its peak just before feeding in the evening. This trend was practically the same for all the rations studied, except when pasture was included in the diet. The results with three different rations are shown in Figure 8.

(Monroe and Perkins)

THE DETERMINATION OF AMMONIA AND UREA IN MILK

It has been shown by the writer in the Fifty-first and Fifty-third Annual Reports, also in Bulletin 515, that urea constitutes about one-half of the non-protein nitrogen in average milk and is the constituent of milk most affected by variations in the level of protein feeding. Ammonia was thought to be affected to some extent by such feeding, but existing methods for its determination were not dependable. A simple method has been developed for the accurate determination of ammonia and also urea in milk.

The milk is first treated with about one-fifth of its own weight of anhydrous magnesium sulfate. Alcohol is then added with one intermediate shaking to a final volume of five times that of the original milk. The material is mixed and filtered, and portions of the filtrate are distilled in the Kjeldahl nitrogen apparatus. The amount of ammonia is determined by titration with N/140 solutions or colorimetrically.

For the determination of urea, a suitable portion of the alcoholic filtrate corresponding to from 1 to 4 cubic centimeters of milk is incubated with an alcoholic extract of jack bean meal or other urease preparation for 2 hours at about 40° C. The ammonia formed by the decomposition of the urea is then determined as indicated above. The observed result is corrected for preformed ammonia, and the remainder is calculated to its equivalent of urea.

Studies by this method have failed to show any considerable difference in the ammonia content of milk due to differences in the protein feeding, as is shown in Table 38.

TABLE 38.—Ammonia Nitrogen Content of Milk

	Mg. in 100 cc. of milk		
	High	Low	Mean
Low protein feeding (four cows, 21 samples)	0.60	0.27	0.42
High protein feeding (three cows, 20 samples)	0.55	0.23	0.41

Recent articles from European sources have claimed that the ammonia determination has considerable advantage and practical utility as a means of judging the sanitary quality of milk. Our work is not conclusive as to the practical value of ammonia determination as a means of sanitary control, but it does constitute a very simple and highly accurate method for ammonia determination. (Perkins)

WHOLE MILK AND MAGNESIUM CARBONATE FOR BONE GROWTH IN DAIRY CALVES

Previous work has shown that bones from milk-fed calves contained about 50 per cent less magnesium than those of calves fed a normal ration of milk, hay, and grain.

This year a study was planned to see what effect inorganic magnesium and whole milk fortified with iron and copper would have upon the bone growth of dairy calves. Three groups of three calves each were used in this experiment. Group 1 received the basal ration containing whole milk, iron chloride, and copper sulfate. Group 2 received, in addition to the basal ration, magnesium carbonate at the rate of 1 per cent of the dry-matter content of the milk. Group 3 received, in addition to the ration fed to the calves in Group 2, adequate vitamin D from a violet-ray lamp.

The duration of this experiment was from birth to 255 days of age. Growth data were practically the same for all groups.

The addition of magnesium carbonate maintained the magnesium content of the blood serum at 2.26 to 2.45 milligrams per 100 cubic centimeters during the last 135 days of the experiment. When no magnesium was fed, the blood magnesium for the same period averaged 1.38 milligrams. Calcium and phosphorus of the blood serum remained at practically the same level for all groups.

The bone ash and physical measurements of certain bones are given in Table 39.

TABLE 39.—Average Ash and Physical Measurements of the Cannon Bones and Ash of the Rib Bones

Group	Cannon bones						Rib bones	
	Fresh weight	Length	Volume	Density	Breaking strength	Bone ash	Fifth rib bone ash	Rib ends bone as
	Gm.	*Cm.*	*Cc.*	*Gm./cc.*	*Lb.*	*Pct.*	*Pct.*	*Pct.*
1	247	21.05	195	1.26	1511	62.17	59.12	53.96
2	241	21.47	191	1.26	1396	62.06	58.93	54.09
3	269	21.50	203	1.32	1611	63.13	59.20	52.94

These results indicate that the gross structure of the calf bones was not changed when magnesium was added to a ration of whole milk, iron chloride, and copper sulfate. The bones studied are being chemically analyzed for magnesium, calcium, and phosphorus. (Knoop, Krauss, and Hayden)

RAW VERSUS PASTEURIZED MILK

Raw milk and pasteurized milk from the same batch were titrated daily with indophenol to determine their ascorbic acid content. These milks were then fed to guinea pigs on a scorbutic diet in amounts that would furnish 0.5 milligram of ascorbic acid daily. The biological response of the pigs fed pasteurized milk was somewhat greater than that obtained with raw milk.

In a succeeding experiment raw milk was compared with pasteurized and boiled milk. All three samples were from the same batch. In this case the milks were titrated for ascorbic acid content but the same volume of each milk

was fed. It was found by titration that the pasteurized milk had lost 9.6 per cent and the boiled milk, 11.6 per cent of the original ascorbic acid content. Biological assay, however, did not show these differences to be so great.

Both of these trials indicated that the titration for reduced ascorbic acid in heated milks may not be a true measure of their vitamin C activity. This was further substantiated in a trial in which the same volume of pasteurized milk was fed to guinea pigs on a scorbutic diet immediately after it was pasteurized and cooled, 6 hours afterward, and 24 hours afterward. The samples were kept in ordinary milk bottles under uncertain refrigeration. The results are presented in Table 40.

TABLE 40.—Loss of Vitamin C from Pasteurized Milk on Storage

	Freshly pasteurized milk	After 6 hours of storage	After 24 hours of storage	Positive controls (0.6 mg. of $C_6H_8O_6$)	Negative controls
Number of pigs	6	6	5	6	5
Gain in weight, gm	108	135	42	177	−66
Days survival	56	56	55	56	13
Scurvy score	3.0	1.5	7.0	0.17	18.0
Loss by titration, pct.	.....	13.3	33.6	.....	.....

(Krauss and Washburn)

PASTURE MILK VERSUS DRY FEED MILK

After repeated trials in which no superiority in growth-promoting properties could be shown for milk produced by pasture-fed cows, some indication of such superiority was shown in the spring of 1936. In attempting to associate this with some particular factor in the milk, cane molasses in one case and grass juice in another were added to a common supply of winter milk and

TABLE 41.—Pasture Milk versus Winter Milk. Total Gains of Rats Fed Mineralized Winter or Pasture Milk

(Paired feeding)

Date	Number (Pairs or triplets)	Kind of milk and supplement	Total gain in weight (6 weeks)
			Gm.
1936			
May 29–July 10.....	6	Winter Milk A*	101
		Winter Milk B*	97
		Pasture milk	111
Aug. 3–Sept. 15.....	5	Winter Milk B	118
		Winter Milk B plus 2.0 cc. of cane molasses	128
		Winter Milk B plus 2.0 cc. of grass juice	117
Aug. 31–Oct. 17.....	8	Winter Milk C*	118
		Pasture milk	98
1937	2	Winter Milk D*	150
May 10–June 23.....		Pasture milk	157
	6	Winter Milk D plus 3.0 cc. of grass juice	142
		Pasture milk	120

*Winter Milk A—Cows received alfalfa hay, corn silage, and high protein grain mixture.
Winter Milk B—Cows received timothy hay, corn silage, and low protein grain mixture.
Winter Milk C—Cow on vitamin A – deficient ration; no hay or silage fed.
Winter Milk D—Cows fed alfalfa hay, corn silage, and normal grain mixture.

compared with it. The grass juice caused no increase in growth but the cane molasses did. In a further trial, in which rats receiving pasture milk were fed cane sugar to equalize the energy intake of the rats on winter milk plus cane molasses, the molasses group again grew better. Although no difference was shown in the growth-promoting properties of spring pasture milk (1937), the addition to winter milk of juice from this pasture resulted in growth superior to that obtained on the pasture milk. These results, Table 41, indicate the presence in cane molasses and in early spring grass juice of a factor which supplements the growth-promoting properties of winter milk.

(Krauss)

STUDIES ON THE VITAMIN C CONTENT OF MILK

As one of the steps in a study to determine the losses of vitamin C that occur in milk from the time it is produced until it is consumed, samples of freshly drawn raw milk and of milk from the same batch that had been stored for 6 to 24 hours, respectively, were titrated for reduced ascorbic acid and fed to guinea pigs on a scorbutic diet.

An equal volume of all these milks was fed. The amount used depended upon the titration value of the fresh raw milk. The stored samples were kept in ordinary milk bottles in a cooler with uncertain refrigeration. No particular precautions were taken in handling the milk to keep it from being exposed to sunlight.

Although the titration values indicated 12.9 and 29.4 per cent losses of reduced ascorbic acid in the 6-hour and 24-hour samples, respectively, the biological values of all three milks were much alike (Table 42).

TABLE 42.—Loss of Vitamin C from Raw Milk on Storage
(Light and temperature not controlled)

	Fresh raw milk	After 6 hours of storage	After 24 hours of storage	Positive controls (0.6 mg. of $C_6H_8O_6$)	Negative controls
Number of guinea pigs	3	5	6	6	5
Gain in weight, gm.	114	156	107	177	−66
Days survival	56	56	56	56	13
Scurvy score	4.0	4.0	6.0	0.17	18.0
Loss by titration, pct.	.....	12.85	29.4	.....	.....

In a repetition of this trial precautions were taken to prevent light from striking the milk, and the storage temperature was kept between 35 and 40° F. The amount of milk fed was based on the titration for reduced ascorbic acid on the fresh milk. The biological responses obtained with each type of milk were very similar and, although in the previous trial the loss of reduced ascorbic acid in the stored milks was very high, in this trial the loss was very low, 2.44 per cent for the 6-hour samples and 2.48 for the 24-hour samples (Table 43).

In spite of the precautions taken, it was found that 10.6 per cent of the ascorbic acid in the fresh milk, 14.6 per cent in the 6-hour sample, and 9.7 per cent in the 24-hour sample had been reversibly oxidized. The inconsistency in the previous trial between biological response and chemical titration for reduced ascorbic acid can probably be explained, therefore, on the basis of reversibly oxidized ascorbic acid, which has been shown to have biological activity.

TABLE 43.—Loss of Vitamin C from Raw Milk on Storage
(Light and temperature controlled)

	Fresh raw milk	After 6 hours of storage	After 24 hours of storage	Positive controls (0 5 mg. of $C_6H_8O_6$)	Negative controls
Number of guinea pigs	4	3	4	2	3
Gain in weight, gm	200	202	183	219	—80
Days survival	56	56	56	56	14
Scurvy score	0.5	2.0	2.5	2.0	15.0
Loss by titration, pct.	....	2.44	2.48	....	.....

These trials suggest that in order to get a value for ascorbic acid in milk by titration which will correspond to the biological response with guinea pigs it is necessary to determine the reversibly oxidized, as well as the reduced form.
(Washburn and Krauss)

EFFECT OF VITAMIN A ON MINERAL ASSIMILATION

Preliminary work on the effect of vitamin A (carotene) on the total retention of calcium and phosphorus by rats suggested that the addition of 5 gamma of carotene daily to a vitamin A – free diet increased the retention of these elements. A more extensive trial, using paired feeding, was made, in which 2.0 gamma, 2.0 gamma, and 5.0 gamma of carotene were compared with no carotene, 0.5 gamma, and 0.5 gamma of carotene, respectively. A vitamin A – free basal diet was fed throughout. Data on a possible progressive change in calcium and phosphorus utilization were obtained by carcass analyses at the end of 4 weeks and 8 weeks. The retentions given in Table 44 were calculated according to the formula,

$$\frac{\text{Ca or P—(Initial Weight x } Ca_1 \text{ or } P_1)\ 100}{\text{Calcium or Phosphorus Intake}}$$

where Ca or P is the calcium or phosphorus in the carcass minus that in the intestinal tract and Ca_1 or P_1 is the percentage of calcium or phosphorus in litter mates killed at the beginning. Different values for Ca_1 and P_1 were used for males and females. The results indicate that no effect is exerted by carotene feeding during the first 4 weeks, but that at the end of 8 weeks the retentions of calcium and phosphorus are correlated with carotene intake. The statistical significance of these data has not yet been determined.

TABLE 44.—Effect of Vitamin A (Carotene) on Mineral Assimilation

	End of 4 weeks		End of 8 weeks	
	Calcium retained	Phosphorus retained	Calcium retained	Phosphorus retained
	Pct.	*Pct.*	*Pct.*	*Pct.*
Vitamin A—free diet	65.43	31.45	57.91	20.75
Vitamin A—free diet plus 2.0 gamma of carotene	63.41	29.59	59.08	23.77
Vitamin A—free diet plus 0.5 gamma of carotene	60.54	28.87	54.66	21.59
Vitamin A—free diet plus 2.0 gamma of carotene	64.37	29.75	57.16	23.54
Vitamin A—free diet plus 0.5 gamma of carotene	63.38	29.50	54.37	22.50
Vitamin A—free diet plus 5.0 gamma of carotene	61.64	30.64	58.68	24.76

(Krauss, Monroe, and Washburn)

STUDIES ON THE ABSORPTION OF ULTRAVIOLET LIGHT BY DAIRY CALVES

In preliminary studies with rats it was shown that ultraviolet light was more effective when applied to the head region than to the unshaved back. It was also shown that when the unshaved back of rachitic rats was irradiated long enough healing could be initiated. These findings prompted a study with calves which, it was hoped, might throw some light on the question of the most efficient placement of ultraviolet lamps in a dairy barn installation.

Three groups of three calves each were placed on a rickets-producing ration at 1 to 3 weeks of age. Group 1 was irradiated directly on the head by placing sunlamps opposite the head position of each calf as it stood in a stanchion. Group 2 was irradiated on the back by similar lamps placed above the center of the back region of each calf as it stood in a stanchion. Group 3 calves served as controls and received neither ultraviolet light nor vitamin D from any source. The daily exposure of Groups 1 and 2 to ultraviolet light was approximately equal to 2 hours of midsummer sunshine.

According to calcium, phosphorus, and vitamin D determinations made on the blood at intervals, the calves in Group 3 (control) developed rickets rather rapidly. The blood of the calves in Group 1 (head-irradiated) was practically normal throughout; whereas that of the calves in Group 2 (back-irradiated) showed some tendency toward rickets development at first but later seemed to approach the values found for the head-irradiated group.

Two calves in each group continued on the experiment for at least 5 months. The final data obtained on these calves represent the over-all effect of their treatment throughout the experiment and are presented in Table 45.

Visual evidence of the results obtained is shown in Figure 9.

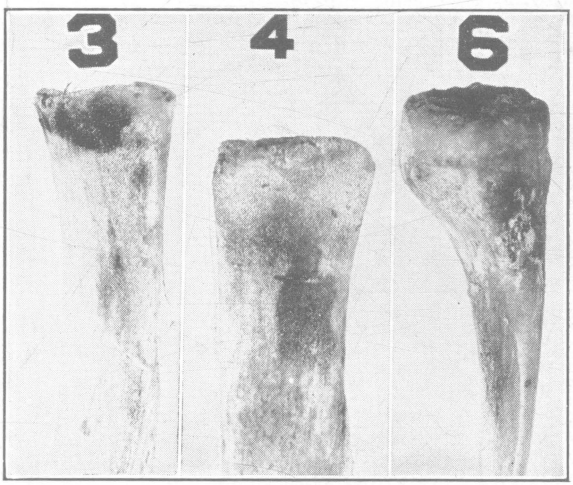


Fig. 9.—Effect of ultraviolet light on calcification in ribs of dairy calves
3—Irradiated on head
4—Irradiated on back
6—Not irradiated

TABLE 45.—Effect of Ultraviolet Light Applied to Different Body Areas on the Prevention of Rickets in Calves

	Group 1 head-irradiated	Group 2 back-irradiated	Group 3 controls
Days on experiment	155	170	147
Ash content of bones, pct.			
Leg	58.64	57.26	53.01
Rib	51.99	50.83	35.33
Breaking strength of cannon bones, lb.			
Front	1165	950	774
Rear	1579	1236	1139
Calcium in blood, mg. per 100 cc	10.34	9.53	6.08
Phosphorus in blood, mg. per 100 cc	7.53	7.34	5.49
Vitamin D in dried blood, line test response to			
3000 mg	0.20	0.25	0.0
4000 mg			0.0

(Krauss and Knoop)

EFFECT OF ULTRAVIOLET LIGHT ON THE HEALTH OF DAIRY CATTLE[9]

Two groups of 48 cows each, selected on the basis of their agglutination titers (blood test reaction), were started during May, 1935, on a trial to determine the effect of ultraviolet light on health. The cows were housed in one barn at the Ohio State Reformatory at Mansfield, and were part of a herd many of the individuals of which were positive to Bang's disease. One group of cows was subjected to ultraviolet light; the other served as a control. During the first year regular General Electric S_1 sunlamps were used. During the second year a special type of bulb was used. It was originally intended that the irradiated cows receive from the lamps an amount of ultraviolet light daily equal to that furnished by 2 hours of summer sunshine. In both years the amount of ultraviolet light received by the cows was much less than this.

In addition to the usual data on production and reproduction obtained in a well-managed herd, agglutination titers on milk and blood, bromthymol blue tests on milk, calcium and phosphorus determinations on the blood, determinations of the iodine content of the thyroid glands of slaughtered animals, and measurements of the vitamin D content of blood and milk were made.

Aside from some indication that the vitamin D content of the blood and milk of the irradiated cows was slightly greater than that of the check cows, the results have been negative. Monthly agglutination tests for Bang's disease with both blood serum and milk, and bromthymol blue mastitis tests showed no significant difference in the changes that occurred. Some variations were observed in individual animals but these appeared equally within the two groups.

The failure to change the agglutination titers is substantiated by the abortion history of the two groups during the 2 years of the experiment and for the two pre-experimental calvings (Table 46).

[9]In cooperation with the Department of Animal Industry; the General Electric Company, Nela Park, Cleveland; and the State Department of Public Welfare.

TABLE 46.—Total Freshenings and Abortions in the Mansfield Experimental Dairy Herd for the Two Calvings Preceding and for the Calvings Occurring During the Use of Sun Lamps in the Dairy Barn

	Second calving preceding		First calving preceding		First year of experiment		Second year of experiment	
	Check	Light	Check	Light	Check	Light	Check	Light
Total freshenings ...	35	34	54	53	48	49	36	39
Abortions	2	4	3	4	6*	2*	0	2
Abortions, pct.....	5.71	11.76	5.66	7.55	12.50	4.08	0.0	5.13

*Two abortions in the check group and one in the light group occurred so close to the beginning of the experiment that they can be excluded. There were on this basis in the check group 46 freshenings and 4 abortions; the percentage of abortions was 8.70. In the light group there were 48 freshenings and 1 abortion; the percentage of abortions was 2.08.

The health histories of calves raised to 6 months of age under lights were better than those of control calves that were not irradiated. Because of some unforeseen factor in management, which may have influenced these results, additional data are being obtained on this point, as well as upon the effect of ultraviolet light on milk production.

(Krauss, Edgington, Monroe, and Hayden)

THE ARTIFICIAL INDUCTION OF OESTRUS IN THE MILK GOAT DURING THE ANOESTRUS PERIOD

In continuation of this project, previously reported in the Fifty-fifth Annual Report, eight does and one male were made available in the anoestrus period for study through the courtesy of the Ohio Milk Goat Breeders' Association. A commercial gonadotropic preparation made from pregnant mares' blood serum was used as a source of gonad stimulating principle.

The goats, male and females, were quartered together for the following reasons: It was impossible to observe the animals at frequent enough intervals to be certain that no heat period would be overlooked. The period during which the female will accept the male may be only a few hours in duration. With the male and females quartered together, it was hoped that mating would occur should a female come into heat at a period when they were not under observation.

The females were injected with 50 and 100 rat units of gonadotropic substance, followed by a second dosage of the same magnitude at an interval of 21 days. The male was injected with 100 rat units at the same intervals. The number of females that exhibited oestrus is not definitely known. However, mating was observed in the case of two, giving definite evidence that the gonadotropic principle of pregnant mare serum did stimulate oestrus in the goat during the anoestrus period. Whether any of the does conceived from the mating during the artificially induced oestrus is not known at this date.

The three does which were brought into oestrus the previous year (see Fifty-fifth Annual Report) by injecting a gonadotropic extract of desiccated anterior pituitaries did not conceive. (Sutton and Krill[10])

[10]Dr. W. R. Krill of the College of Veterinary Medicine, the Ohio State University.

THE EFFECTS OF VITAMIN A DEFICIENCY ON REPRODUCTION

THE EFFECTS OF A DIET LOW IN VITAMIN A ON THE MICROSCOPICAL STRUCTURE OF THE GONADS

Earlier investigators have shown that definite degenerative changes occur in the gonads of animals on diets low in vitamin A. In this study an attempt has been made to determine the extent of the degeneration, any sex differences which might exist, and the possibilities of recovery when the diet is again adequately supplemented.

The animals (white rats) used in this study were depleted of vitamin A by feeding a diet usually employed for this purpose. When the rats were virtually depleted, the diet was supplemented with 1 U. S. P. unit of vitamin A. Later the supplement was increased to 1.4 U. S. P. units. About 7 to 8 weeks following depletion, part of the animals were sacrificed, and parts of their reproductive organs were saved for histological study. These included testes from the males and ovaries, uteri, and vaginae from the females.

Microscopic examination of these tissues showed extensive degenerative changes in the gonads. These changes included complete or almost complete degeneration of the germinal epithelium of the testes and a marked increase in the number of atretic follicles, together with an overgrowth of connective tissue and a decrease in the number of corpora lutea in the ovary. However, in many cases there was still evidence of ovarian activity.

In addition to the changes which have previously been reported as regularly occurring in the uterus and vagina, cornification of the uterine glands was found. This change was usually accompanied by the formation of a small cyst.

To determine whether the damage inflicted on the gonads was beyond repair, attempts were made to stimulate activity in these organs. The remaining animals were divided into two groups. One group was fed an adequate supplement of vitamin A in addition to the basal ration (10 U. S. P. units for 4 weeks followed by 20 U. S. P. units for 2 weeks). These animals were then sacrificed and the gonads prepared for microscopic examination. In no instance was there complete regeneration of the germinal epithelium of the testes, and in most cases no repair whatsoever was noted. On the other hand, in most cases the ovaries showed evidence of at least a partial return to normal activity, as evidenced by the number of active follicles and fresh corpora lutea.

The animals of the other group were injected with pregnant mares' serum which had previously been assayed for gonadotropic activity. The females received a single injection of this serum, equivalent to approximately 1 rat unit. The males received four daily injections of 2 rat units each. Macroscopic and microscopic examinations of the gonads from this group following the gonadotropic treatment showed evidence of marked stimulation in case of the ovaries, but no stimulation in case of the testes.

This study presents evidence that vitamin A deficiency is more likely to cause profound and permanent injury to the male gonad than to that of the female.

THE EFFECTS OF VITAMIN A DEFICIENCY ON THE PITUITARY GLAND

The changes noted in the gonads of animals receiving a diet low in vitamin A may be either primary or secondary. That is, the degenerative changes may be a direct result of the dietary deficiency on the gonad itself, or these changes may result from a decrease in the production of gonad stimulating hormone by the pituitary gland.

To test this question, it was decided that pituitaries from vitamin A – deficient animals should be studied both for changes in structure and biological activity. Pituitary glands from the animals used in the above study were used for this study.

Pituitaries from the animals were prepared for histological study by a technique which stains differentially the various types of cells present in the anterior pituitary and makes possible a rather accurate count of the various types. Although this study is not complete, sufficient counts have been made to demonstrate rather interesting changes.

Table 47 summarizes the data obtained from the histological study of the females of this group. For comparison, data are also included for normal females and castrate females.

TABLE 47.—Cellular Elements of Anterior Pituitaries from Normal Females, Vitamin A – deficient Females, and Castrate Females

Condition of animals	Number of animals	Cell types in per cent			
		Chromophobes	Eosinophils	Basophils	Castration cells*
Normal	10	52.43	37.26	10.39	0.66
A-deficient	10	46.05	41.27	12.61	0.80
Castrate	10	39.50	43.69	16.83	6.08

*Castration cells are basophilic cells and are included with the basophils.

It is interesting to note that the cellular changes of the pituitary in vitamin A deficiency are in the same direction as the changes produced by castration. In fact, vitamin A deficiency might be considered as a partial castration effect. Inasmuch as it is known that the biological activity of the pituitary is increased by castration, it is logical to assume that in vitamin A deficiency, the activity of the pituitary is increased, since the cellular changes are in the same direction. Pituitaries from another group of animals are being assayed to test this assumption. Although at the present time the data accumulated are insufficient to justify any conclusions, the indications are that the gonadotropic activity of the pituitary is increased in animals receiving diets low in vitamin A.

It is very well established that a reciprocal hormone relationship exists between the gonad and the pituitary. Any influence which lowers the activity of the gonad results in a compensatory increase in the activity of the pituitary. The data accumulated to date in this experiment indicate that a deficiency in dietary vitamin A has a direct damaging influence on the gonad. Impairment of the normal activity of the gonad results in cellular changes of the anterior pituitary which are accompanied by an increase in gonadotropic activity.

(Sutton and Brief[11]

[11]J. B. Brief, graduate student in the College of Medicine, the Ohio State University.

THE VITAMIN C CONTENT AND PIGMENT CONCENTRATION IN FIELD-GROWN TOMATOES, 1937

In cooperation with the Department of Horticulture, 71 field varieties of tomatoes were analyzed for acidity and ascorbic acid content by titration. The acidity of the expressed pulp ranged from pH 3.88 to 4.44, and the ascorbic acid content, from 0.1138 to 0.4635 milligram per cubic centimeter.

Total pigment (lycopene plus carotene) was determined on 56 field varieties of tomatoes spectrophotometrically[12]. Total pigment concentration varied from 0.0018 to 0.0970 milligram per gram. Only four varieties (white or yellow) were found to contain carotene by this method. The pigment in pink and red varieties was practically all lycopene, but biological assay and use of an adsorption tower demonstrated the presence of appreciable amounts of carotene. Apparently, small amounts of carotene (up to 4 per cent) in a mixture containing large amounts of lycopene cannot be detected on a spectrophotometer. (Washburn, Hoffman, and Krauss)

VITAMIN D MILK ASSAYS[13]

During the period July 1, 1936, to June 30, 1937, 62 samples of vitamin D milk produced in the State were assayed for vitamin D. The results of these assays are given in Table 48.

TABLE 48.—Results of Assays on Vitamin D Milk

Kind of vitamin D milk	Number meeting requirement	Number below requirement	Total
Vitex	35	1	36
Sun-A-Sured	9	4	13
Metabolized	11	0	11
Irradiated	1	1	2
			62

(Krauss and Bethke)

[12]In cooperation with the S M. A. Corporation, Cleveland, Ohio.

[13]In cooperation with the Department of Animal Industry.

ANIMAL INDUSTRY

CATTLE EXPERIMENTS

QUANTITY OF PROTEIN FOR USE WITH A HEAVY SILAGE RATION FOR FATTENING YEARLING STEERS

A 240-day test using 16 yearling steers weighing 730 pounds in each lot was conducted at the Madison County Farm.

The corn crop yielded 3.73 tons per acre, or 15.5 bushels of corn. This low yield was due to the extreme drouth.

A supplement composed of 2 parts soybean oil meal, 1 part tankage, and 1 part cottonseed meal was used for Lot 2, at the rate of 2 pounds daily per steer. The supplement fed to Lot 1 was a mixture of the above supplement and ground shelled corn, equal parts. The corn was added to compensate for the carbohydrate and fat in the extra pounds of protein concentrates fed Lot 2 without materially increasing the protein content.

As much silage and legume hay were fed as the steers would eat. This amounted to 43.5 pounds of silage and 2.75 pounds of hay daily for each lot. During the last 58 days of the test, corn-and-cob meal was added to the ration, in order to lengthen the feeding period. The corn-and-cob meal consumption averaged about 8.75 pounds daily for each lot during the 58 days it was fed.

There was no apparent difference in the performance of the two lots at any time during the test. Lot 1 gained 2.02 pounds daily during the test; Lot 2 gained 2.00 pounds daily.

There were some people who preferred the finish of Lot 2, although most felt that no apparent difference existed. (Gerlaugh and Rogers)

DECREASING THE CORN CONTENT AND INCREASING THE LEGUME HAY CONTENT OF RATIONS FOR YEARLING STEERS

Three lots of 720-pound yearling steers were used in the 252-day test, conducted in the feed lots at the Ohio State University.

Fifteen pounds of silage and 1.5 pounds of supplement were fed daily per steer in all lots. A full feed of corn-and-cob meal was fed to Lot 1; Lot 2 was fed three-fourths as much corn-and-cob meal as Lot 1 ate; and Lot 3 was fed one-half as much as Lot 1. Legume hay, clover or alfalfa, was fed to all lots in such amounts as the steers would eat. Lot 1 consumed during the test an average of 13.2 pounds of corn and 3.8 pounds of hay; Lot 2, 10.05 pounds of corn and 7.4 pounds of hay; Lot 3 averaged 6.7 pounds of corn and 9.9 pounds of hay. Lot 1 gained 1.85 pounds daily; Lot 2, 1.76 pounds; and Lot 3, 1.75 pounds.

On the basis of acre yields of 50 bushels of corn, 10 tons of silage, and 2 tons of hay, there was a gain of 337 pounds per acre of feed, other than supplement, fed to Lot 1. Lot 2 returned 321 pounds per acre, and Lot 3, 341 pounds.

The cattle sold through an auction ring, September 2, at $18.50 per hundredweight for Lots 1 and 2 and $17.75 for Lot 3. The premium paid for the higher finish on Lots 1 and 2 made the returns from feeding the larger amounts of corn the most profitable. (Gerlaugh and Gay)

QUANTITY OF SUPPLEMENT FOR FATTENING STEER CALVES

Five lots, 20 head to the lot, of 345-pound steer calves were used in the 308-day test, which started December 8.

All lots were fed 7 pounds of silage and 1.5 pounds of mixed clover and timothy hay daily per calf. All lots were full-fed shelled corn. A supplement consisting of 30 parts dry rendered tankage, 30 parts soybean oil meal, 20 parts cottonseed meal, 15 parts linseed meal, 2 parts bone meal, 2 parts limestone, and 1 part salt was used.

Lot 1 was fed 1.6 pounds of supplement daily per calf throughout the test. Lot 3 was fed 2.4 pounds of supplement throughout the test. Lot 4 was fed 2.4 pounds daily during the first 24 weeks of test and 1.6 pounds during the last 20 weeks. Lot 5 was fed 1.6 pounds daily during the first 24 weeks and 2.4 pounds during the last 20 weeks. Lot 2 was fed 0.8 pound during the first 12 weeks, 1.6 pounds during the second 12 weeks, 2.4 pounds during the third period of 12 weeks, and 3.2 pounds during the last period of 8 weeks.

Lot 1 had an average daily gain of 2.0 pounds for the entire test; Lot 2, 2.13 pounds; Lot 3, 2.18 pounds; Lot 4, 2.12 pounds; and Lot 5, 2.19 pounds.

The larger amounts of supplement fed were associated with larger amounts of total concentrate consumed and more rapid daily gains. Of the 20 different periods in the test there was only one exception to the above statement. This was the last period of Lot 3.

Lot 2, which started on the low level and was fed increasing amounts of supplement as the feeding period advanced, produced the ripest lot of cattle, according to government graders. This lot did not make the most gain during the test. It made the poorest gain during the first period, but the best gains during the last two periods. Relative prices of corn and supplement determine the profitableness of the larger amounts of supplement. During this test the higher levels of supplement gave the cheapest, as well as the most rapid, gains.

(Gerlaugh)

SWINE EXPERIMENTS

SELF-FEEDING THE SUPPLEMENT WHEN EAR CORN IS FED TWICE DAILY TO PIGS ON PASTURE

Pigs on alfalfa pasture that were fed ear corn twice daily but that were self-fed tankage took 0.5 pound of tankage daily a head, or 1 pound for every 6.5 pounds of corn, which was more than was needed. Although the proportions required at different times varied, mixing ground oats, ground alfalfa, or a 3:1 mixture of limestone and bone meal with the tankage, was an effective method of keeping the tankage consumption down to amounts averaging from 0.29 to 0.36 pound daily a head.

The oats averaged 2.2 pounds for each pound of tankage but varied from a 1:1 ratio at the beginning to a 3:1 ratio at the close. The ground alfalfa and the minerals averaged 1 pound to approximately 4 and 8 pounds of tankage in their respective mixtures. (Robison)

IRON-TREATED EXPELLER COTTONSEED MEAL FOR PIGS

Three comparisons of expeller cottonseed meal treated with a solution of ferrous sulfate (as described on page 86 of Bulletin 579) and mixtures of dry rendered tankage or meat and bone scraps and linseed meal, both fed with

yellow corn, ground alfalfa, and minerals to pigs in dry lot, were made. The pigs on the two supplements as named gained 1.03 and 1.25 pounds daily a head and required averages of 4.4 and 4.2 pounds of feed per pound of gain produced. Of the 33 head fed the cottonseed meal none died or was removed.

A group of pigs fed equal parts of iron-treated expeller cottonseed meal and meat and bone scraps required 0.8 per cent more feed per unit of gain and reached a similar market weight 9 days later than a group fed equal weights of linseed meal and meat and bone scraps. The remainder of each ration was made up of yellow corn, ground alfalfa, and minerals.

In a different experiment, in which each was used as the only protein concentrate along with yellow corn, ground alfalfa, and minerals, pigs fed iron-treated expeller cottonseed meal required 2.8 per cent more feed per unit of gain and 7 days more time to reach a similar market weight than pigs fed linseed meal. The iron-treated expeller cottonseed meal and the linseed meal did not differ greatly in efficiency whether they were used in combination with tankage or meat and bone scraps, or as the only protein concentrate in the ration. (Robison)

TOASTED SOLVENT SOYBEAN OIL MEAL FOR PIGS

Pigs in dry lot fed toasted solvent soybean oil meal with corn, ground alfalfa, and minerals took 36 per cent more feed daily a head, gained 70 per cent faster, and required 20 per cent less feed per unit of gain than those fed solvent soybean oil meal with the same feeds. In one previous test, similar results, except that the differences were much smaller, were secured. In another, pigs on the ration containing the toasted solvent soybean oil meal ate more feed daily a head but made slightly slower gains and required 4 per cent more feed per unit of gain than those on the ration containing the solvent soybean oil meal. The rapidity of the gains agreed with that in the other tests when only the pigs remaining in the lots at the close of the test were considered.

The pigs fed the toasted solvent soybean oil meal consumed somewhat less feed and gained less rapidly but required only 1.6 per cent more feed per unit of gain than those fed a mixture of linseed meal and meat scraps.

In four dry-lot trials, without exception, pigs fed solvent soybean oil meal as a protein concentrate with corn, ground alfalfa, and minerals made slower gains and less gain per unit of feed than those fed expeller soybean oil meal or a mixture of tankage or meat scraps and linseed meal. The average gains were 0.84, 1.21, and 1.29 pounds daily a head, and the average amounts of feed per 100 pounds of gain, 473, 392, and 402 pounds, respectively. (Robison)

HYDRAULIC AND EXPELLER SOYBEAN OIL MEALS FOR PIGS

In a dry-lot experiment comparing the two for feeding with corn, ground alfalfa, and minerals, 15 pigs receiving hydraulic soybean oil meal and 15 receiving a nut-like expeller soybean oil meal gained 1.34 and 1.23 pounds daily a head and consumed 365 and 384 pounds of feed per 100 pounds of gain, respectively. (Robison)

DRIED SKIM MILK WORTH MORE FOR YOUNG THAN FOR OLDER PIGS

In each of four indoor trials, carried on in cooperation with the American Dry Milk Institute, dried skim milk was added at a low and at a higher level to a ration of yellow corn, tankage, linseed meal, ground alfalfa, and minerals. Except in the first trial, cod-liver oil was also included in the rations.

The low level of dried milk averaged 1.1 per cent of the feed and 5.8 per cent of the supplement and was equivalent to about 0.5 pound of liquid skim milk daily a head. The higher level averaged 4.5 per cent of the feed and 23.5 per cent of the supplement and was equivalent to about 2 pounds of liquid milk daily a head.

With ground corn, tankage, linseed meal, ground alfalfa, minerals, and cod-liver oil at 1.225, 2.5, 1.8, 1.2, 2.0, and 11 cents a pound, respectively, the amounts of these replaced by the dried skim milk, when the pigs were between approximately 38 and 115 pounds in weight, gave it values, at the low and at the higher level, of 10.1 and 4.5 cents a pound, respectively. The values obtained for the dried skim milk at the low and at the higher level, after the pigs weighed 115 pounds, or during the fattening period, were 5.6 and 2.3 cents a pound, respectively.

Using dried skim milk at a medium level, which averaged 2.7 per cent of the feed and 13.4 per cent of the supplement and was equal to about 0.8 pound of liquid milk daily a head, during the growing period and no milk during the fattening period was tried in three of the trials. The pigs so fed and those fed dried milk at the low level for the entire time returned values of 7.7 and 6.6 cents a pound, respectively, for the dried milk. (Robison)

GROUND AND WHOLE OATS FOR PIGS

Grinding the oats that were used in a ration containing an average of approximately 1.33 pounds to each pound of mixed supplement, or a little over 1 pound to every 3 pounds of corn, paid when the pigs, which were indoors and were carried from approximately 44 to 200 pounds in weight, were self-fed. When similar pigs were fed twice daily rather than self-fed, the advantage of ground oats over whole oats was still greater. (Robison)

SHEEP EXPERIMENTS

CARBONACEOUS ROUGHAGES IN RATIONS FOR EWES AND LAMBS

Experiments reported in the Fifty-fourth and Fifty-fifth Annual Reports showed that lamb rations composed of farm-grown grains, protein supplement, and timothy hay were deficient in calcium, and that the calcium deficiency could be corrected by feeding 200-mesh limestone flour. Also, experiments were reported in which timothy and other carbonaceous roughages which are similarly low in calcium were successfully used for breeding ewes when fortified with adequate protein supplement and limestone to furnish calcium. The tests conducted during the winter season of 1936-1937 were made to confirm previous results.

CORN SILAGE AS THE ONLY ROUGHAGE FOR EWES

Corn silage was fed as the only roughage in the winter ration of pregnant and nursing ewes during the winter seasons of 1934-1935, 1935-1936, and again during 1936-1937. This 1936-1937 test confirmed the previous experiments. A winter ration containing an average of 0.4 pound of mixed grain (oats, 3 parts; corn, 1; wheat, 1; barley, 1), 0.3 pound of protein supplement, 0.67 ounce of 200-mesh limestone, and 6.76 pounds of corn silage was compared with a ration

containing, on the average, 0.6 pound of mixed grain, 0.1 pound of protein supplement, 2.5 pounds of legume hay, and 2.4 pounds of corn silage. No significant differences were noted in the performance of the two lots of Merino ewes in health, thrift, or condition. Lambs were born equally strong and thrifty. The lambs from the silage-fed lots of ewes did not gain as rapidly as those from the ewes which had legume hay in their ration. The slower gain indicates a somewhat lower milk supply from the silage-fed ewes during the 45-day nursing period covered by the test. (Bell and Kick)

CORN SILAGE AS THE ONLY ROUGHAGE FOR FATTENING LAMBS

Corn silage made from Clarage corn and put into the silo when the corn was dented and starting to glaze was fed as the only roughage to a lot of 30 white-faced, tight-fleeced western lambs. The average ration for the 98-day feeding period was 1.05 pounds of shelled corn, 0.24 pound of protein supplement, 0.5 ounce of 200-mesh limestone flour, and 2.03 pounds of corn silage. The lambs made an average daily gain of 0.331 pound per head, which was equal to the gain made by lambs fed a similar grain ration but with 0.64 pound of early cut timothy hay and 1.17 pounds of corn silage. In comparison with a check lot of lambs fed 1.14 pounds of shelled corn and 1.82 pounds of clover hay, the all-silage lot showed just 0.88 pound less gain per lamb than the lambs fed shelled corn and clover hay. The silage-fed lot suffered slightly greater mortality, but the indications were that this was a chance occurrence.

(Bell and Kick)

TIMOTHY HAY AS A ROUGHAGE FOR BREEDING EWES

The seventh feeding experiment involving the use of timothy hay as the dry roughage for wintering pregnant and nursing ewes was conducted during the winter of 1936-1937. One lot of 42 purebred Delaine Merino ewes was fed a winter ration which averaged 0.67 pound of corn and oats, 0.15 pound of protein supplement, 2.22 pounds of alfalfa hay, and 2.5 pounds of corn silage per ewe per day. A second lot of 42 similar ewes was fed a winter ration which averaged 0.43 pound of corn and oats, 0.4 pound of protein supplement, 0.75 ounce of 200-mesh limestone, 1.9 pounds of early cut timothy hay, and 2.5 pounds of corn silage per ewe per day.

In previous tests timothy hay fortified with enough protein supplement to give the ewes about 0.3 pound of digestible protein daily and 0.75 to 0.8 ounce of 200-mesh ground limestone to supply calcium showed a production record nearly equal to that of a similar lot fed good quality alfalfa hay. In this test the ewes fed timothy hay did not equal in performance the group fed extra choice quality second cutting alfalfa hay. However, the timothy-fed ewes wintered satisfactorily. They were noticeably thinner in condition at the close of the test than the alfalfa lot but were, nevertheless, averaging about 1 pound heavier at the close of the test on April 21 than when the test started on December 2. The alfalfa-fed ewes averaged nearly 10 pounds heavier at the close of the test than when winter feeding was begun. This ewe performance in the two lots is probably a reflection of the winter ration in which the alfalfa-fed ewes consumed nearly 0.33 pound more per head per day of the highly palatable alfalfa than the other lot ate of the somewhat less palatable timothy.

Also, the 0.25 pound of protein supplement necessary in the timothy lot replaced corn and oats which the alfalfa-fed ewes consumed and which contributed to the fatter condition of the alfalfa-fed group of ewes.

A summary of the seven feeding experiments in which timothy was used as roughage in the winter ration of pregnant and nursing ewes shows that alfalfa or clover hay is superior to timothy hay on a pound for pound basis, and on this basis sheep growers should strive to provide legume hay for their flocks. If legume seedings fail or other factors intervene so that legume hay is not available, timothy hay may be used satisfactorily, provided it is cut not later than blooming time and is fortified at feeding time with adequate protein supplement (about 0.4 pound per ewe per day) and enough 200-mesh limestone flour (about 0.75 ounce per ewe per day) to furnish calcium.

(Bell, Thatcher, and Kick)

FATTENING WESTERN LAMBS

The experiment to study the influence of feeder lamb weight on feed-lot performance and final carcass finish reported in the Fifty-fifth Annual Report was repeated, with minor changes, during the winter of 1936-1937. Six lots of 30 white-faced, tight-fleeced western lambs each were fed shelled corn and legume hay. The different weight classes were represented by lambs in each of the six lots, averaging, respectively, from Lot 1 to Lot 6, 72.3, 62.6, 53.4, 50.3, 44.8, and 36.2 pounds. The lots were fed for 74, 84, 98, 112, 112, and 119 days, respectively, and to an average final weight of 97.2, 90.4, 89.3, 89.0, 82.8, and 75.7 pounds for each lot, respectively.

The weight of the feeder lambs at the start did not influence the efficiency of the lamb as a machine for converting corn into meat and wool, since all lots required nearly the same quantity of corn per hundred pounds of gain in live weight. Hay consumption per hundred pounds of gain was progressively less as the weight of feeder lamb was lower. Because the feeding periods varied in length, it required 1.4 bushels of shelled corn to fatten a lamb in the heavy-weight class and from 2.25 to 2.3 bushels of shelled corn to fatten lambs of the 50-pound, 45-pound, and 36-pound classes of feeder lambs. One ton of clover hay was sufficient to fatten 10 lambs, irrespective of their weight class. On this basis, the relative price and relative supply of corn and hay are important factors to be considered in selecting the weight class of lambs for the feed lot.

(Bell)

NUTRITIONAL EXPERIMENTS

RIBOFLAVIN (VITAMIN G) ESSENTIAL IN POULTRY NUTRITION

A continuation of the Station's studies on the function and importance of riboflavin in poultry nutrition has shown definitely that it is required in avian nutrition. Chicks on a ration deficient in riboflavin grow poorly, and a variable percentage develop a characteristic leg disorder. The feeding of 40 micrograms or more of either a pure crystalline natural or a synthetic riboflavin daily per chick increased growth markedly and also prevented the occurrence of the leg disorder.

Experiments on hatchability also showed that riboflavin was essential in embryonic development. Hens on a ration deficient in flavin produced eggs of which only 4.2 per cent of the fertile ones hatched. The feeding of 100 micro-

grams of riboflavin per hen daily increased the hatchability of the fertile eggs to 53.3 per cent. When the flavin intake was increased to 200 micrograms daily, 80.7 per cent of the fertile eggs hatched. A further significant observation made was that the hatchability of the fertile eggs decreased from 80.7 per cent to below 5.0 per cent in 2 weeks after flavin feeding was discontinued.

(Bethke and Record)

THE STABILITY OF CAROTENE AND VITAMIN A IN A MIXED RATION

Experiments were conducted with chicks and rats to obtain information on the stability of the vitamin A in cod-liver oil and the carotene in alfalfa leaf meal when these materials are incorporated in mixed rations and stored at near room temperature. Two different vitamin A – deficient rations were used. One ration consisted of white corn, wheat middlings, casein, irradiated yeast, and minerals; the other was similar to it, but meat scraps and dried skim milk replaced the casein. Dehydrated alfalfa leaf meal and Reference cod-liver oil were incorporated in each of the two rations to supply 75, 150, and 225 units of vitamin A per 100 grams of ration.

The mixed rations were fed to chicks and rats when first mixed and again after storage periods of 3 and 6 months. The results showed that there was a loss of vitamin A from cod-liver oil and carotene from alfalfa leaf meal on both rations, but that the loss was much greater in the meat scraps – dried milk ration than in the casein ration. The loss of vitamin A or carotene was, however, not complete even after a storage of 6 months.

(Bethke, Record, and Wilder)

OBSERVATIONS ON THE VITAMIN A REQUIREMENTS OF LAYING BIRDS

In a continuation of the studies on the vitamin A requirements of laying birds, eight groups of White Leghorn pullets were used. Four of these groups were reared on range and four, in confinement, receiving known amounts of carotene (200, 400, 800, or 1600 micrograms per 100 grams of feed) in their ration from date of hatching. A basal ration of white corn, wheat middlings, wheat bran, ground whole oats, meat scraps, dried skim milk, irradiated yeast, and minerals was used, to which dehydrated alfalfa leaf meal was added to supply 200, 400, 800, or 1600 micrograms of carotene per 100 grams of feed.

The results of this trial indicate that a minimum of approximately 400 micrograms of carotene from alfalfa leaf meal was required per 100 grams of feed for good egg production and hatchability.

(Record, Bethke, Wilder, and Chamberlin)

THE RIBOFLAVIN (VITAMIN G) REQUIREMENT OF THE CHICKEN

This project is a continuation of the experiments reported in Bulletin 579 (Annual Report, 1935-1936) in cooperation with the Poultry Department of the Ohio State University. White Leghorn pullets raised on a ration of yellow corn, wheat, wheat bran, Argentine casein, minerals, and cod-liver oil failed to lay; whereas normal range-reared pullets, when put on the same flavin-deficient ration, laid normally for a few months and then ceased. Eggs from these birds

failed to hatch. When 5.0 per cent of alfalfa leaf meal or 5.0 per cent of dried skim milk was added to the above rations, egg production and hatchability were improved. However, for maximum results 10 per cent of dried skim milk, or 5.0 per cent of dried skim milk and 5.0 per cent of alfalfa leaf meal were necessary. The above supplemental rations contained from 250 to 300 micrograms of flavin per 100 grams of feed, according to the rat assay method. Biological rat assays of the experimental rations show that there is a correlation between their riboflavin (vitamin G) content and growth, egg production, and hatchability. (Hunt and Winter)

STUDIES IN THE VITAMIN B GROUP

Methods of separating the various factors that make up the vitamin B group, as found in yeast, continued to be the main object of this study. Five separate fractions were studied with rats. It was found that the feeding of the fractions which contained vitamin B_1, riboflavin, and the rat antidermatitis factor (vitamin B_6) produced normal growth. No further response in growth was noted when the above fractions were supplemented with the vitamin B_1 and flavin-free fuller's earth adsorbate or the N/10 barium hydroxide elute of the fuller's earth adsorbate from a water extract of yeast.

(Hunt and Bethke)

THE LOSS OF CAROTENE IN DEHYDRATED ALFALFA LEAF MEAL STORED UNDER DIFFERENT CONDITIONS

To determine the amount and rate of loss of carotene in dehydrated alfalfa leaf meal stored under different conditions of temperature and in different types of containers, portions of a meal were stored in paper and gunny sacks in a room at outdoor temperature, in a heated room, and in the freezing room of a refrigerator. Four per cent of ball-milled oatmeal was added to other samples stored at room temperature. Carotene analyses were made at monthly intervals for a period of 1 year on all samples.

The results showed that there was a progressive loss of carotene in all samples. The amount of loss was closely correlated with the storage temperature, ranging from a 27 per cent loss in the refrigerated sample to an 80 per cent loss in the samples stored in the heated room. The rate of loss of carotene in the sample stored at outdoor temperature was roughly correlated with the outdoor temperature and reached 61 per cent after 1 year.

The type of container, whether paper or gunny sack, or the addition of the oatmeal flour had no effect on either the rate or amount of destruction of carotene in the samples. (Wilder and Bethke)

POULTRY EXPERIMENTS

THE RATION AS AFFECTED BY FREE-CHOICE FEEDING OF WHOLE GRAIN AND MASH

The free-choice feeding of whole grain and a mash has become a popular method of feeding. A frequent question in connection with free-choice feeding is whether layers can be depended upon to balance their own ration properly. Results of tests carried on at this Station indicate that they can. Flocks varied greatly in the proportion of whole corn, wheat, or oats they consumed,

but the proportion of total grain to mash was comparatively constant and in proportion to the protein content of the mash. To put it differently, the birds appeared to balance their ration pretty closely on the basis of protein content. When the birds received a mash with varying percentages of protein (18 to 24 and 32) the percentages of mash consumed were 41 to 33 and 20, respectively; on this basis the percentage of protein of the total feed intake was 14.6, 15.3, and 15.2. The rate of egg production affects mash consumption and, incidentally, the protein intake.

From the Station's tests, free-choice feeding of whole grain and mash appears to be equally as satisfactory as all-mash or the usual grain and mash rations, provided the birds have ample opportunity to become fully accustomed to this method of feeding before they come into egg production.

(Kennard and Chamberlin)

LAYING BATTERIES VERSUS FLOOR PENS FOR LAYERS

The first tests with caged layers at the Ohio Station were begun in 1924, or just about as soon as it became known how to feed chickens so that they could live indoors. Numerous tests with caged layers have been in progress almost continuously during the past 14 years. Since 1933, when commercial equipment became available, tests of livability and egg production of layers in batteries versus similar layers in floor pens have been under way.

In 17 tests during the past 5 years, the layers in batteries averaged 148 eggs per bird against 150 from similar layers in floor pens. The rates of mortality were 35.8 and 49 per cent, respectively.

The birds were fed a coarse all-mash feed mixture. The principal difference in nutritive requirements was that the birds in batteries required more supplemental vitamin D (perhaps 50 to 75 per cent more) than the floor birds. Batteries have their advantages and disadvantages as do floor pens. Although laying batteries offer promising commercial possibilities, they must still be regarded as being in their experimental stage of development.

(Kennard and Chamberlin)

LIVABILITY AND EGG PRODUCTION OF PULLET LAYERS AS AFFECTED BY THEIR PREVIOUS MANAGEMENT

Since the appearance of fowl paralysis and allied complications among the Station's flocks in 1928, the chief problem in the operation of the poultry plant has been the heavy losses of pullet layers. Numerous tests of different management procedures with chicks and growing pullets designed to prevent or reduce the losses of pullet layers (often reaching 50 to 60 per cent) have been in continuous progress during the past 9 years. Among the procedures tested were fresh range, used range in the proximity of older birds, wire sun porch, and batteries. Regardless of the first methods of procedure, the mortality of pullet layers remained practically the same, although the fresh-range pullets consistently laid more eggs.

When the first management procedures failed it was supposed that the breeding stock was responsible. Accordingly, ready-to-lay pullets were purchased from two different sources. Both came through the year with a low rate of mortality and high egg production. Since it was believed that the superiority of the imported pullets was due to their breeding, hatching eggs were secured from one of the sources of imported pullets. The chicks and

pullets from the imported hatching eggs were raised in the proximity of the Station's poultry plant. The pullet layers from these eggs proved even a worse failure than the Station's pullets, as did the pullets the following year from day-old chicks and hatching eggs from another source, supposedly free from the diseases affecting the Station's flocks. These 2 years' failure with outside stock made it plain that after all it must have been a management problem that began with the day-old chick and continued until the pullet was ready to lay. If so, it was obvious that the previous management tests had failed to meet the requirements. In order to eliminate the unforeseeable chances for exposure of the chicks and pullets to diseases of older birds, day-old chicks were sent to the Miami and Clermont County Experiment Farms in 1935 and 1936. The pullets, when ready to lay, were returned to the Station for test purposes. Both groups yielded high egg production with a low rate of mortality the first year. During the past year the pullets from the one farm repeated the good results of the previous year, but those from the other did not on account of an outbreak of coccidiosis, which, of course, was a management problem. During the year 1936-1937, 1500 chicks were raised on an isolated range near the Station's poultry plant where management precautions were taken that would generally be considered practicable by poultry raisers. Test groups of these pullets yielded an average of 29 per cent more eggs with 30.6 per cent (34 versus 49) less mortality than did the pullets raised without the special management precautions. Although the results were not as favorable as when the pullets were raised at the experiment farms entirely away from the poultry plant, repeated tests will be necessary before the merits of the modified procedure are determined.

In the 11 tests during a period of 3 years with pullet layers subjected to preventive management versus nonpreventive management while chicks and growing pullets, the average mortality was 28 versus 59 per cent, and the eggs per bird were 182 versus 147.

Until more definite research information becomes available, preventive management procedures (particularly the isolation of chicks and growing pullets from older disease-carrying birds or the disposal of all chickens, depopulation, 4 to 6 weeks before bringing day-old chicks to the place and the use of hen breeders), uncertain as they may be, undoubtedly offer a poultry raiser coping with an acute disease and parasite (internal) situation the best promise for near future relief.

What is needed for the ultimate solution of the pullet mortality problem is more definite and comprehensive research information relative to the causes and means of transmission of diseases, including the role of "carriers" or "hosts" in the dissemination of diseases and internal parasites. With such information available, effective prevention and control measures (preventive management) could be more intelligently undertaken.

(Kennard and Chamberlin)

ANIMAL DISEASE INVESTIGATIONS

CRYSTAL VIOLET VACCINE FOR THE PREVENTION OF HOG CHOLERA

The work with crystal violet vaccine is a continuation of that given in last year's report.

Eight new lots of vaccine were prepared. Each lot proved to be avirulent in tests made of the vaccines immediately following completion of their preparation.

Immunity tests made 3 to 4 weeks after administration of the vaccines gave evidence of satisfactory protection by each.

Immunity tests 3 months after injection of the vaccine are now in progress. (Edgington)

LOSSES IN FEEDER LAMBS

A condition frequently called "apoplexy" or "overeating disease" of lambs was investigated to ascertain its possible causal relationship to that of infectious enterotoxemia as reported from Australia. Toxicity of bacterial-free filtrates of material obtained from the small intestine of affected lambs was determined by mouse inoculations.

Such filtrates proved to be toxic in each of two outbreaks investigated. A lamb inoculated subcutaneously with one of these filtrates died 4 hours after the inoculation and showed symptoms similar to those observed in spontaneous cases of the disease.

Tests of intestinal filtrates obtained from eight apparently healthy lambs at time of slaughter gave no evidence of toxicity. (Edgington and Bell)

PSEUDORABIES TRANSMISSION

A calf was exposed by pen association to 19 wild rats that had been fed the carcasses of pseudorabies-infected rabbits. Three rats died from this exposure and were fed to two pigs which were kept in another pen in direct contact with a second calf. The pigs showed temperature elevation following their feeding on the rats. Nasal washings from these pigs were shown to contain the virus of pseudorabies.

Neither of the calves gave evidence of having acquired the infection. These results are in accord with those obtained in similar tests which were reported last year. (Edgington and Frank)

MASTITIS IN CATTLE

Two State institution herds are being used as sources of material for studies of this disease.

Periodic observations are being made upon the animals in these herds.

The examinations include:

1. Repeated physical examinations and charting of the udders of each animal in the herds
2. Determination of the bacterial flora of all udders
3. Histopathological examination of tissue obtained from all cows slaughtered out of these herds
4. Carrying out other techniques pertinent to the detection of udder changes and conditions

A sufficient amount of information has not yet been obtained to support definite statements at this time. (Schalk, Edgington, and Sutton)

DIGESTION IN CATTLE

EFFECT OF MECHANICAL PROCESSING OF FEEDS ON MASTICATION AND RUMINATION

MASTICATION

The number of chews and the time spent in mastication were both reduced as the size of the hay particles became smaller from either cutting or grinding. Grinding shelled corn increased the length of time and the number of chews

made in mastication. The animals spent from 1.4 to 11.0 per cent of the daily time in mastication. The time depended on the ration. The more roughage in the ration, the greater was the number of chews made and the length of time required.

RUMINATION

Cutting alfalfa hay or grinding shelled corn made no difference in the number of chews, boluses, or the time spent in rumination. However, grinding hay reduced these indexes. Rumination required from 4.5 to 36.4 per cent of the daily time. An important factor in the amount of rumination was the amount of roughage in the ration. Steers fed shelled corn and protein supplement without any roughage ruminated listlessly and seemed to do it from habit rather than from necessity.

EFFECT OF MECHANICAL PROCESSING OF FEEDS ON DIGESTIBILITY

Cutting alfalfa hay appeared to have no effect on the digestibility of the various nutrients; whereas grinding alfalfa hay decreased the digestibility of the nutrients, with the exception of ether extract, the digestibility of which was increased. Grinding corn seemed to increase the digestibility slightly. The digestibility coefficients of the nutrients of corn-and-cob meal were approximately the same as those of shelled corn, but it must be remembered that 70 pounds of corn-and-cob meal are equivalent to 56 pounds of shelled corn (on a basis of shelled corn); therefore more nutrients were actually obtained from the corn-and-cob meal. Differences in age of the animals had no apparent effect in these changes.

RETENTION TIME OF WHOLE CORN KERNELS IN THE RUMEN

Although corn kernels could be found in the feces within 8 hours after feeding, the whole kernels might remain in the rumen for 6 days. The age of the animal, amount of corn fed, or the corn-hay ratio had no effect on the time of retention. The only factor studied which directly affected this was the physical condition of the rumen ingesta. Whenever the animal was in poor physical condition (listless, rough hair coat, and the like), regardless of degree of fleshing, the ingesta was dry and the corn and roughage formed a rather solid ball in the rumen. The amount of rumination was not affected to any appreciable extent, but the corn was probably regurgitated and remasticated with the hay. Under these conditions, the corn left the rumen within 24 hours and no whole kernels appeared in the feces.

SALIVA STUDIES

Less saliva was mixed with the alfalfa hay during mastication as the hay particles fed became smaller. In the case of grains, such as corn, oats, barley, and wheat, cracking, rolling, or grinding increased the amount of saliva secreted during mastication. The specific gravity of whole saliva was 1.005 to 1.010, and its pH was approximately 8.4. The whole saliva contained 1 per cent of dry matter and 0.64 per cent of ash.

pH OF THE INGESTA

The pH of the ingesta varied from 5.5 to 7.7, depending on the ration. When alfalfa alone was fed the ingesta was most alkaline. As the amount of corn in the ration was increased the pH was lowered. Diurnal variations occurred according to the time of feeding. After feeding, the pH fell for a period of 8 hours. When the animals were fed again, the pH again fell, at a slower rate, for about 8 hours. Then the pH began to rise, and it reached a peak just before feeding in the morning. (Kick, Gerlaugh, Schalk, and Silver)

A SURVEY OF SHEEP PARASITES FOR OHIO

A parasite survey has been made of 44 head of native sheep secured from 11 flocks located in six Ohio counties. These sheep were obtained from two types of flocks, 24 head from flocks being treated for internal parasites and 20 head from flocks not being so treated for parasites. Each flock surveyed was represented by two adults and two lambs. A complete flock history of each flock was obtained at the time selections were made and each sheep selected was appropriately tagged for future identification.

All sheep selected were brought to the Animal Disease Laboratories at Reynoldsburg, Ohio, where parasite egg counts were run on fecal samples collected from each sheep on 3 successive days. After the fecal examinations were completed, all sheep were slaughtered; the carcasses were salvaged; and all viscera were collected and examined for parasites.

The average number of parasite ova per gram of feces in the adult sheep was 445; the average count in the lambs was 1672 ova per gram of feces. Thus, the average count in the lambs was nearly four times greater than in the adult sheep. Although the average parasite ova counts per gram of feces were 10 per cent greater in untreated than in treated adults, such was not the case with the lambs. The average count in the treated lambs was over 40 per cent greater than that in the untreated lambs.

TABLE 49.—Species of Parasites Found and Percentage of Treated and Untreated Sheep Infested

Location and species of parasites	Treated sheep		Untreated sheep	
	Adults	Lambs	Adults	Lambs
	Pct.	*Pct.*	*Pct.*	*Pct.*
Lungs				
Dictyocaulus filaria	0.0	50.0	0.0	60.0
Stomach—abomasum				
Haemonchus contortus	33.3	66.6	50.0	60.0
Ostertagia circumcincta	75.0	91.6	70.0	60.0
Small intestines				
Bunostomum trigonocephalum	83.3	75.0	90.0	80.0
Cooperia (spp.)	58.3	58.3	70.0	70.0
Nematodirus (spp.)	50.0	66.6	40.0	60.0
Trichostrongylus (spp.)	8.3	83.3	10.0	100.0
Monieza expansa	8.3	0.0	40.0	30.0
Ceca and large intestines				
Trichuris ovis	8.3	50.0	10.0	60.0
Esophagostomum columbianum	83.3	75.0	100.0	100.0
Chabertia ovina	0.0	16.6	0.0	20.0
Sinuses				
Oestrus ovis (larvae)	50.0	83.3	70.0	70.0
Peritoneal cavity				
Cysticercus tenuicollis	41.6	8.3	30.0	0.0

(Woodhouse, Bear, and Rebrassier)

SHEEP PARASITE EXPERIMENTS

The various gastrointestinal parasites to which sheep are susceptible continue to exact a heavy toll in Ohio's untreated flocks. Medicinal agents, given largely as drenches, directed against these parasites have been helpful in reducing excessive loss. Occasionally, however, losses in the flock from reduced thrift, inability to grow and fatten, and sometimes death, occur in spite of regular medicinal treatment. In 1935, which proved to be a year of severe parasitism, losses were excessive and some recommended medicinal agents seemingly were not effective. It was thought that the use of anthelmintics alone would not control this condition and that some other methods would have to be developed.

Studies of the problems of gastrointestinal parasites in sheep were initiated in 1936 by the divisions of sheep husbandry and animal parasitology. A program was arranged to investigate three phases of the problem, namely:

1. To determine the length of time various parasite larvae will survive on infected pastures
2. To determine the efficiency of various anthelmintics against the common gastrointestinal parasites
3. To determine the value of sheep management and pasture rotation in reducing gastrointestinal parasitism

The entire program is now in operation; however, the only data available at this time relate to results obtained from the first year's work in the third phase of the investigation.

This sheep management and pasture rotation test was based principally on the results of previous experiments reported in Bulletin 401 and was conducted at the Southeastern Experiment Farm, Carpenter, Ohio. The test, designated as the improved management plan, consisted in raising all of the ewe lambs and one-half of the wether lambs in the barn until weaning time. These lambs were gradually placed on a grain ration, not to exceed ½ pound per head daily, and had access to all the legume hay they would consume. Each morning the dams were turned to pasture. They were returned to their lambs in the evening and remained with them during the night. After weaning, the lambs were placed on pasture, supposedly free of parasite infection and continued to receive ½ pound of mixed grain daily.

The second half of the wether lambs, which constituted the control lot, ran with the dams on infected pastures and were fed no grain.

Parasite infection was determined by slaughtering several wether lambs from each lot at weaning time, at close of the grazing season, and at the end of the winter feeding period. Both lots were found to be infected, in varying degree, with the following parasites: *Haemonchus contortus* (common stomach worm), *Ostertagi ostertogi* (small stomach worm), *Bunostomum trigonocephalum* (hookworm), *Oesophagostomum columbianum* (nodular worm), *Trichuris ovis* (whipworm), *Moniezia expansa* (tapeworm), *Chabertia ovina*, *Trichostrongylus* spp., and *Cooperia* spp. The last three species are small nematode parasites found in the intestinal tract.

When lambs raised under the improved management plan were slaughtered and their parasite infection was compared with that of the control lot, it was found that the average infection with *Haemonchus contortus* was reduced 43.4 per cent; that with *Bunostomum trigonocephalum*, 99.46 per cent; and that with *Oesophogostomum columbianum*, 99.34 per cent. The average infection

of *Ostertagi* spp., *Cooperia* spp., and *Trichostrongylus* spp. was considerably reduced in the improved management lot, but no percentage figures were obtained because these worms are so small that actual count is not feasible. *Chabertia ovina, Moniezia expansa,* and *Trichuris ovis* infection was light in both lots. The data also indicate that the final results may give valuable information with respect to the time that lambs become infected with the various parasites.

The development of these lambs, as measured by the average live weight of the lambs at various seasons, was strikingly in favor of the improved management system, as is shown by Table 50.

TABLE 50.—Average Weight of Wether Lambs at Seasonal Intervals

	At start April 16, 1936	At weaning July 7, 1936	Close of grazing November 4, 1936	At shearing May 18, 1937
Control lot	24.4	42.1	52.6	87.1
Improved management lot	24.3	52.5	70.5	103.3

(Bell, Rebrassier, and Woodhouse)

HOME ECONOMICS

NUTRITIONAL STATUS OF COLLEGE WOMEN IN RELATION TO THEIR DIETARY HABITS

This project is being carried on as part of a regional project in cooperation with workers in several North Central States.

ANTHROPOMETRIC MEASUREMENTS

A small group of freshman women was measured during the winter of 1937. Results of measurements showed a wide variation in heights and weights, as well as in the other measurements taken. The size of the group was too small to justify drawing any conclusions. Similar measurements will be taken for this group during each of the 3 succeeding college years. A larger group, approximately 200 freshman women, was measured during September and October, 1937. Measurements of these women will be taken during the succeeding college years as for the smaller group. The data thus collected, with similar data being gathered in cooperating institutions, should give pertinent information concerning size of young college women and also show whether increase in stature, weight, arm girth, and other measurements continues during this period of young adulthood.

BLOOD STUDIES

Eighteen freshman women were subjects in this study, which is a contribution from the Division of Medical and Surgical Research of the College of Medicine. Routine blood counts were obtained at 2-week intervals and chemical determinations of blood iron levels were made once every 4 weeks. A remarkable constancy in both serum iron and "easily split-off" iron levels was found.

BASAL METABOLISM

The basal metabolism of 17 freshman women whose ages ranged from 17 to 23 years was observed. Energy production of each subject was calculated in terms of total calories, calories per kilogram, calories per centimeter per 24 hours, and calories per square meter per hour. On this basis, average figures for the group were 1253, 20.64, 7.64, and 33.46.

Table 51 shows the average heat production of these freshman women, a group of 91 girls from 14 to 18 years of age, and a group of 73 older women. All the data in Table 51 are results of studies made in this laboratory. On the

TABLE 51.—Average Heat Production of Women of Three Age Groups

Age group	Number of subjects	Calories per 24 hr.	Calories per kg. per 24 hr.	Calories per cm. per 24 hr.	Calories per sq. m. per hr.
Young women, 14–18	91	1364	25.40	8.40	36.40
College freshmen, 17–22	17	1253	20.64	7.64	33.46
Older women, 35 or over	73	1326	20.68	8.19	32.72

basis of surface area, heat production shows a definite decline as age increases, and the energy-production figures of the freshman women occupy a position between the figures for the younger and older groups.

BALANCE STUDIES

Calcium, phosphorus, and protein balances were made for four freshman women who were eating their customary diets. For two of the women, two 5-day periods during winter and spring were used. This made a study of a total of 20 days' intake and output for each. During the spring, one of the women increased the amount of milk in her diet, thus increasing her calcium intake. For the other two women, two 5-day periods, a total of 10 days each, were used.

Results of the study show average calcium intakes ranging from 645 to 1044 milligrams daily and average outputs of 419 to 1103 milligrams. In only four of the twelve 5-day periods was the calcium intake equal to or greater than the calcium output.

Average phosphorus intakes ranged from 653 to 1067 milligrams daily with outputs ranging from 621 to 1231 milligrams. Four periods of positive balance were found during 12 observation periods of 5 days each.

Nitrogen used in the diet ranged from a daily average of 5.91 to 9.42 grams with outputs averaging from 5.00 to 11.71 grams. In three of the 12 observation periods, positive balances were found.

For the periods studied, this group of young women was in slightly negative balance in regard to calcium, phosphorus, and nitrogen. Further study of these same individuals and others is needed to ascertain to what extent young women are storing these elements and what standards of intake are desirable.

FOOD INTAKE ANALYSIS

Each of the four freshmen included in the balance study weighed her food intake for periods varying from 2 to 5 weeks. Samples of each week's diet equivalent to one-tenth of the amount eaten were used to determine the calorie value of each week's diets. Average daily calorie intakes as determined through the use of the oxycalorimeter are given in Table 52.

TABLE 52.—Average Calorie Intake per Day as Shown by Oxycalorimetry

Subject	Length of period	Minimum	Maximum	Average
A	5 weeks	1246	1780	1558
B	4 weeks	1635	1908	1804
C	2 weeks	1694	2085	1890
D	2 weeks	1916	1997	1956

As shown by the results in Table 52, calorie intake of these college women is considerably below the usually accepted standards. If studies of a larger group show corresponding results, standards for energy requirements of college women will need revision.

QUALITATIVE RECORDS

A group of 125 freshman girls kept a record of all food eaten during a period of 1 week in the autumn of 1936. The records were summarized as to the frequency with which milk, vegetables, fruits, whole grain products, meat, eggs, coffee, tea, Coca Cola, and vitamin concentrates appeared.

Results of the summary showed that 7 per cent of the group had neither citrus fruit nor tomatoes; 10 per cent had no milk; 40 per cent never used whole cereal products; and 54 per cent had no eggs during the week's period.

About 75 per cent of the group had meat daily and 80 per cent of the group had green or yellow vegetables at least three times a week. About 30 per cent of the group had from one to two cups of milk daily. Only about 13 per cent of the group had more than two cups of milk daily. Coffee or tea was used daily by about one-fourth of the group.

The results seem to indicate that the findings of the newer knowledge of nutrition are very slowly being used by intelligent young women in their food selection and indicate the need of instruction.

(Hughina McKay and Mary Brown Patton)

CULINARY QUALITY OF OHIO POTATOES

This study as described in previous reports has been continued, and an attempt has been made to correlate specific gravity with average score for culinary value. The potatoes averaging the highest score (8.38) had the highest specific gravity (1.089); those averaging the lowest score (6.99) had the lowest specific gravity (1.070). Observation of specific gravity may prove to be serviceable in estimating the culinary quality of potatoes.

(Hughina McKay and Mary Brown Patton)

TEXTILES RESEARCH

Work was completed on the project, The Influence of Position Isomerism in Azo Dyes upon Their Fastness to Light and Washing. II. The report is to be published in bulletin form. Some of the results of this project and of the preceding project, The Influence of Position Isomerism (Structural Differences) in Azo Dyes upon Their Fastness to Light and Washing, were published in The American Dyestuff Reporter in February, 1937.

The two projects, The Absorption Spectra of Isomeric Azo Dyes, and The Effect of Certain Chemicals During the Washing Process upon the Fastness Properties of Some Widely Used Dyestuffs, have been completed. Reports are being submitted for publication. (Marion E. Griffith)

RURAL ECONOMICS

STUDIES RELATING TO AN AGRICULTURAL LAND-USE PROGRAM IN OHIO

In cooperation with the United States Department of Agriculture and the Departments of Agronomy and Animal Husbandry of the Ohio Agricultural Experiment Station, the study relating to an agricultural land-use program for Ohio was continued. In the Annual Report for 1934-1935 were reported the results of a study carried out by the Experiment Station workers which was intended to show the changes in acreage necessary in Ohio agriculture if the productivity of the soil was to be maintained. During the past year groups of farmers in every county in the State were asked to work out adjustments in acreage which in their opinion would be desirable if the soil productivity of their county was to be maintained. A compilation of the results of their work shows the following major changes recommended: that 800,000 acres of land now in farms in the State be transferred to forestry uses; that the acreage in hay and rotation pasture be increased by 22 per cent; that livestock be excluded from one-half of the woodland now pastured; that the soil-building qualities of the meadow and pasture crops be approximately doubled by including more legumes. (Falconer)

TENANCY AND SOIL MAINTENANCE

In farm management studies made in 10 Ohio areas in 1936, farms were grouped on the basis of "annual soil productivity balance", a term used to designate the estimated annual rate at which the productivity of the soil is being built up or depleted. Tenancy data were secured in five of the areas. In each of these areas, farms on which the best job of soil improvement or maintenance was being done were operated largely by owners or related tenants. Tenants unrelated to the owner were found to a greater extent operating farms on which soil productivity was being depleted most rapidly. It is not meant to be inferred that all tenants follow cropping practices which deplete the soil, nor is the reverse true in the case of owners.

Table 53 shows another grouping of the same data. Three times as large a percentage of owner-operators were maintaining their soil productivity as were unrelated tenants. About one out of every six owner-operators and one

TABLE 53.—Tenancy as Related to Soil Productivity Balance, Five Ohio Areas

Tenure	Total number of farms studied	Farms on which soil productivity was being maintained or improved		Farms on which soil productivity was being depleted at 0.5 per cent or more annually		Productivity balance, all farms, per cent
		Number of farms	Per cent of farms	Number of farms	Per cent of farms	
Owner.....	169	39	23.1	29	17.2	—0.24
Tenant, related	40	8	20.0	8	20.0	—0.26
Tenant, not related.....	68	5	7.4	21	30.9	—0.39

out of every three unrelated tenants were following cropping practices that would result in depletion of their soil productivity at the rate of ½ to 1¼ per cent annually.

The tenant who expects to remain only a short time on a farm or is uncertain whether he will derive benefit from the use of fertilizer and manure or the sowing or plowing under of soil-building crops has little incentive to maintain the productivity of the soil. This is a situation for which tenant farmers have received more than their share of the blame. In this study numerous cases were found where the landlord took little or no interest in the purchase of clover seed or the use of fertilizer or lime. The fact that two families, owner and tenant, must derive their income from a single farm often leads to the planting of larger acreages of corn than are advisable, with little regard for future yields. (Morison)

EFFECT OF MILK MARKETING PLANS ON RETURNS TO PRODUCERS

An analysis of producer returns per hundred pounds of milk sold in the Stark County marketing area indicated that variations of as much as 42 cents per hundred may result entirely from the proportions of base and excess, or surplus, milk marketed. The monthly sales of 107 producers for the years 1935 and 1936 were analyzed. When butterfat and transportation variables were eliminated, there remained the effect of the distribution of sales between base milk and excess over base, or surplus.

In 1935 the producer with the poorest adjustment of base sales to excess received an average return of $1.42 for milk of 3.5 per cent butterfat content f. o. b. dealer's city platform. The producer with the best distribution of base and excess received an average of $1.84. In 1936 the range within the same group was from $1.62 to $1.89, a difference of 27 cents.

Producer bases are determined by production in the low months of total market receipts. The proportion of base milk in total sales depends upon two factors, herd management and market deliveries. Some producers have adjusted their breeding so that they have a high base and a small percentage of excess over base.

In this market producers are permitted to withhold excess milk from the market pool. Those who did so generally increased their average returns from milk going through the market pool and received somewhat higher prices for the excess sold into cheese and sour cream outlets than for that which they marketed through the pool as excess milk.

The practice of withholding milk from the market pool may, however, reflect in the base allotted for the succeeding year. Because of this the problem becomes a complex one. As an illustration, in 1936 producer No. 2 in the above analysis sold 30,000 pounds of milk outside the pool to a cheese factory. For it he received an average net return 20 cents higher than the return he would have received selling it as excess milk through the pool. As a result of this procedure, however, he reduced his allotted daily base for 1937 by 19 pounds. If he markets in 1937 the same number of pounds he did in 1936 and prices remain the same, he will lose 365 times 19, or 6935, pounds of base sales and will sacrifice 21 cents per hundredweight if he sells this milk to the cheese factory, or 41 cents if he sells it as excess in the pool. (McBride)

CHANGES IN VOLUME OF MILK DELIVERIES BY INDIVIDUAL MILK PRODUCERS

The study of farm sales of milk in four Ohio markets has been continued during the past year. This study includes records back to 1927 in all four markets and back to 1925 in two markets. The records of over 2,000 milk producers selling in the Cincinnati, Dayton, Columbus, and Canton markets are included. The purpose of this study is to determine what changes came about in the deliveries and butterfat test of the milk of a large group of individual milk producers under different buying plans and different economic conditions.

The milk producers were divided into different groups on the basis of yearly sales of milk. Table 54 shows the percentage of the total number of producers falling into each size class, by years, from 1930 to 1936, inclusive.

TABLE 54.—Percentage of Milk Producers of Four Ohio Markets by Amount of Yearly Shipments, by Years, from 1930 to 1936

Yearly volume of shipments, in pounds	1930	1931	1932	1933	1934	1935	1936
Below 10,000	4.8	3.5	3.1	5.0	2.4	1.8	1.7
10,000-19,999	17.9	19.8	23.6	22.6	16.5	16.2	13.7
20,000-29,999	19.0	20.8	24.7	24.9	22.2	23.3	21.3
30,000-39,999	16.9	18.5	18.7	17.3	20.1	19.1	18.4
40,000-49,999	13.6	12.6	10.9	10.9	12.5	14.3	14.4
50,000-59,999	8.1	8.0	7.5	7.8	7.8	8.7	10.7
60,000-69,999	6.7	5.3	3.6	3.9	5.4	4.8	5.9
70,000-79,999	3.5	3.7	2.2	2.4	4.2	3.4	4.0
80,000-89,999	2.7	2.5	2.0	1.7	2.3	2.4	2.6
90,000-99,999	2.2	1.5	1.0	1.0	2.2	1.6	2.0
Over 99,999	4.6	3.8	2.7	2.7	4.4	4.4	5.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The most important change has been the big decrease in the percentage of producers delivering less than 10,000 pounds of milk per year. This decrease can be accounted for mostly in the decrease in number of small shippers in the Dayton market. In this market the percentage of these small milk producers, in the sample of over 800, had dropped from 14 in 1930 to 3 in 1936. Many of those producers accounting for the decrease in percentage had increased production; some others had dropped out of milk production entirely.

A very noticeable increase in the percentage of small deliveries occurred in 1932 and 1933 when milk prices were at a low level. However, during 1936 only 15.4 per cent of the total number of producers delivered below 20,000 pounds of milk, as compared with 22.7 per cent in 1930. This was accompanied by an increase in practically every group delivering above 20,000 pounds yearly.

(Sherman)

STUDY OF PRODUCTION AND MARKETING OF POTATOES IN NORTHEASTERN OHIO

Yields and marketability of late potatoes grown in northeastern Ohio by about 500 growers in 1936, together with the cultural practices employed, have been subjected to examination and analysis to provide a factual basis for improvements in the potato industry in the State. Types and sources of seed were listed. Spraying, fertilization, harvesting, and other cultural and handling methods were recorded. Five hundred and one samples (100 pounds each)

of potatoes were inspected at digging time to determine the amounts and types of defects and percentages meeting the requirements of United States Grade No. 1. Relationships of cultural practices to yields and quality have been determined, as illustrated in Table 55.

TABLE 55.—Potatoes: Quality, Yield, Acres Harvested, and Number of Growers Reporting, Northeastern Ohio, 1936

Cultural practices	Number of growers	Acres harvested	Average yield per acre	Average per cent of crop grading U. S. No. 1
			Bu.	
Planted certified seed	30	610.5	282.57	69.33
Planted seed 1 year from certification	163	16,338.8	248.98	67.23
Planted uncertified seed	139	988.9	215.05	67.11
Planted treated seed	40	497.0	265.59	68.48
Planted untreated seed	331	3,125.1	238.91	67.91
Vines sprayed	196	2,447.7	260.28	68.55
Vines not sprayed	172	1,142.2	213.14	66.91

Comparative returns to growers have been calculated. For example, aside from the differences in quality, the average yield from certified seed was 67.52 bushels per acre more than that from uncertified seed, and 33.59 bushels per acre more than that from seed 1 year from certification.

The farm price of potatoes in Ohio from September 15 to December 15 in 1936 averaged $1.21½ per bushel. Thus, the gross return from potatoes grown from certified seed on these farms averaged $82.04 per acre more than that from uncertified seed, and $40.81 more than that from seed 1 year from certification.

The cost of certified seed averaged about 35 to 40 cents a bushel more than the cost of other seed in the spring of 1936. With a differential of 40 cents, the additional cost for 20 bushels of certified seed per acre was only $8.00. This left a net gain of approximately $74.00 per acre from the use of certified seed, almost $33.00 more than that obtained from the use of seed 1 year from certification. (Hauck)

ANALYSIS OF 1936 OPERATIONS OF THE LAKE SHORE GROWERS' COOPERATIVE AUCTION, INC.

During the year the Department of Rural Economics made an analysis of the operations of the Lake Shore Growers' Cooperative Auction, Inc. It was discovered that most of the goods sold was offered in small lots. Eighty per cent of the lots contained not more than 10 packages each, and 60 per cent, not more than five packages each.

This emphasis on small, diverse offerings was to a considerable degree responsible for the auction's failure to attract large buyers and more buyers regularly. The association's facilities for wholesaling were employed in a sense largely for retailing. The many small sales occupied an amount of time disproportionate to their value, were unduly costly to handle, and delayed the movement of goods through the auction. The delays created considerable impatience among sellers and buyers.

TABLE 56.—Lake Shore Growers' Cooperative Auction, Inc. Sales by Lots and Packages, 1936

Number of packages per lot	Lots		Packages	
	Number	Per cent of total	Number	Per cent of total
1- 5 inclusive	2,704	60.41	7,072	20.91
6-10 inclusive	883	19.73	6,972	20.61
11-15 inclusive	358	8.00	4,590	13.57
16-20 inclusive	209	4.67	3,785	11.19
21-25 inclusive	118	2.64	2,721	8.04
26-30 inclusive	60	1.34	1,689	4.99
31-35 inclusive	40	0.89	1,323	3.91
36-40 inclusive	27	0.60	1,031	3.05
41-45 inclusive	19	0.42	826	2.45
46-50 inclusive	17	0.38	834	2.47
Over 50	41	0.92	2,980	8.81
Total	4,476	100.00	33,823	100.00

(Hauck)

FACTORS INFLUENCING FARMERS TO MARKET COOPERATIVELY

What were the factors that induced farmers to market livestock cooperatively the first time? This question was put recently to a number of farmers in five areas in Ohio in a study carried on by the Rural Economics Department. A portion of the study was carried out in cooperation with the Farm Credit Administration. It was found that individual farmers, neighbors, and friends were mentioned most frequently as the important reason for inducing farmers to market cooperatively the first time (Table 57). Curiosity, in that the cooperative was a different or new agency, was mentioned as the second most important factor. This means that many farmers will try out a new agency in their territory; if their experience is satisfactory, they may become regular patrons. There is a large group of farmers who have what we might call a cooperative loyalty. They believe in cooperatives. Naturally this group will gravitate toward cooperative agencies. This was the third factor in importance mentioned. A fourth was the desire for a better market.

TABLE 57.—Factors That Influenced the Farmers Interviewed to Make Their First Cooperative Shipment, in Five Ohio Areas

Factors	Cincinnati	Auglaize	Cleveland	Columbus	Pickaway	Total
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Neighbors, farmers, friends, and others	32.4	.....	17.1	10.3	5.7	19.3
Desire to try cooperatives	18.0	22.8	8.6	10.3	15.1	14.6
Belief in farmers' cooperatives	19.4	18.3	4.3	10.3	7.5	12.9
Desire for a better report	7.2	31.8	8.6	12.2	24.6	12.6
Farm Bureau membership	9.4	4.5	5.7	.....	7.5	6.4
Rebates	3.5	9.1	5.7	10.3	7.5	6.1
Other reasons	5.1	13.5	22.8	27.6	24.6	16.1
No answer	5.0	.....	27.2	19.0	7.5	12.0
Total, per cent	100.0	100.0	100.0	100.0	100.0	100.0
Total, number	139	22	70	58	53	342

These four factors accounted for about 60 per cent of the reasons given as influencing farmers. However, the same factor was of varying importance in different areas. In the Pickaway and Auglaize areas, the desire for a better market was the reason most frequently given; whereas in the Cleveland and Cincinnati areas solicitation by neighbors, farmers, and others ranked first among the reasons given. In the Columbus area all four factors were of equal importance.

If cooperatives are to expand their membership, it is necessary that farmers participate in cooperative activities. Table 57 lists the factors farmers gave as important in influencing them to market cooperatively. Cooperative management should not neglect these points.

(Henning)

RURAL REAL ESTATE FORECLOSURES

The Department of Rural Economics has assembled data monthly since July, 1933, on rural real estate foreclosure sales in Ohio.

During the 4 years ending in June, 1937, more than 4700 separate tracts of rural real estate covering 371,000 acres were sold in foreclosure proceedings to settle mortgage debt. This represents a total area about one-third larger than the average Ohio county and covers about one-third of all farm real estate foreclosures since 1925.

Various sections of the State have had different experiences in respect to the frequency of foreclosure sales. The data in Table 58 show that for each 1000 farms located in the area, Northeastern Ohio had 27 foreclosures of rural real estate in 4 years; Northwestern Ohio, approximately 20; Southwestern Ohio, 15; and Southeastern Ohio, 12. In the eight most populous counties, which have high land values, rural real estate foreclosures in 4 years averaged 18.89 sales per 1000 farms, only slightly more than the State average of 18.08. The poorer hill sections of the State have had the fewest foreclosures of all areas, probably because of the very moderate use of mortgage credit facilities there. Some of the most productive counties in the State have had a high rate of foreclosure. Some counties of very moderate productivity have had a relatively high rate of foreclosure and some, a low rate. It may be concluded that maladjustments in farm mortgage credit may arise from numerous causes associated with overcapitalization that may be present in any location.

TABLE 58.—Foreclosure Sales of Rural Real Estate in Four Areas

Area	Number of foreclosure sales per 1000 farms*								
	July-Dec. 1933	Jan.-June 1934	July-Dec. 1934	Jan.-June 1935	July-Dec. 1935	Jan.-June 1936	July-Dec. 1936	Jan.-June 1937	Four years (July, 1933-June, 1937)
Northwestern Ohio....	2.68	3.14	3.77	3.03	2.28	1.91	1.60	1.32	19.71
Northeastern Ohio....	3.26	2.94	3.08	4.85	3.48	3.51	3.16	2.67	27.01
Southeastern Ohio....	1.43	1.51	1.53	1.79	1.60	1.67	1.49	0.98	11.97
Southwestern Ohio....	2.54	2.01	1.99	2.70	2.07	1.57	1.36	1.11	15.35
Total State.....	2.41	2.37	2.57	2.99	2.29	2.12	1.85	1.47	18.08

*As counted in the 1935 Census of Agriculture.

Improvement in mortgage credit difficulties took effect first in Northwestern Ohio. In that area the peak of foreclosure sales during this period occurred in the last half of 1934. The peak was 6 months later in the other three-fourths of the State. The rate of decline has been approximately the same in all sections since January, 1936. (Moore)

FARM POPULATION ESTIMATES

During the year a project was undertaken in cooperation with the Federal Bureau of Agricultural Economics to estimate the number of persons living on Ohio farms on January 1 each intercensal year and also the number of persons moving to and from farms during the year. For this purpose, questionnaire returns were obtained from more than 1400 correspondents in the State. These schedules, covering the correspondent's farm and all adjoining farms, constituted a 3.5 per cent sample of the farms of the State. Table 59 presents a summary of the estimates.

TABLE 59.—Estimated Changes Occurring in the Farm Population of Ohio January 1, 1936, to January 1, 1937, by Section

Factors of change	The State	Section		
		Southeastern	Urban-industrial	Western
Farm population, Jan. 1, 1936	1,137,900*	333,404	300,406	504,090
Gains during 1936	52,159	18,824	14,295	19,040
Births	15,910	5,950	3,660	6,300
Moved to farms from cities, towns, and villages	35,685	12,310	10,635	12,740
Farm to farm migration	564	564	.....	.....
Losses during 1936	58,439	18,185	16,035	24,219
Deaths	12,215	4,045	3,175	4,995
Moved from farms to cities, towns, and villages	43,640	14,140	12,045	17,455
Farm to farm migration	2,584	.....	815	1,769
Farm population, Jan. 1, 1937	1,131,620	334,043	298,666	498,911

*Estimate by Bureau of Agricultural Economics.

(Lively)

RURAL SOCIAL SUBAREAS OF OHIO

Policies for the orderly development of rural life of Ohio assume a knowledge of the social geography of the State. Such knowledge is also necessary for the conduct of scientific studies based upon some sampling procedure. For these reasons, a project was undertaken, in cooperation with the Resettlement Administration, to develop a method of determining the homogeneous rural social subareas of Ohio. It was learned that the three most significant factors for delimiting subareas were "gross cash receipts per farm", "plane of living index", and "rural population fertility". The first two were most significant and far from identical. (Lively)

AGRICULTURAL ENGINEERING

COMBINE HARVESTER INVESTIGATIONS

A project was started in 1936 to determine the efficiency of combine harvesters under Ohio conditions. This work was continued through the 1937 season. Fortunately, from an experimental point of view, the weather conditions of the two seasons were vastly different. In 1936 the crop and weather conditions were nearly ideal. In 1937 they were just the opposite. According to the official records, the rainfall in Ohio for July, 1936, was 3.06 inches. For the same month in 1937 the rainfall was 4.27 inches. This heavy rainfall during and previous to the month of July, 1937, fostered a very heavy weed growth which made harvesting operations difficult. This caused, in many cases, a heavy grain loss in harvesting and produced a low quality of threshed grain. In several cases the difference in moisture content between the threshed and unthreshed grain was as high as 4 per cent.

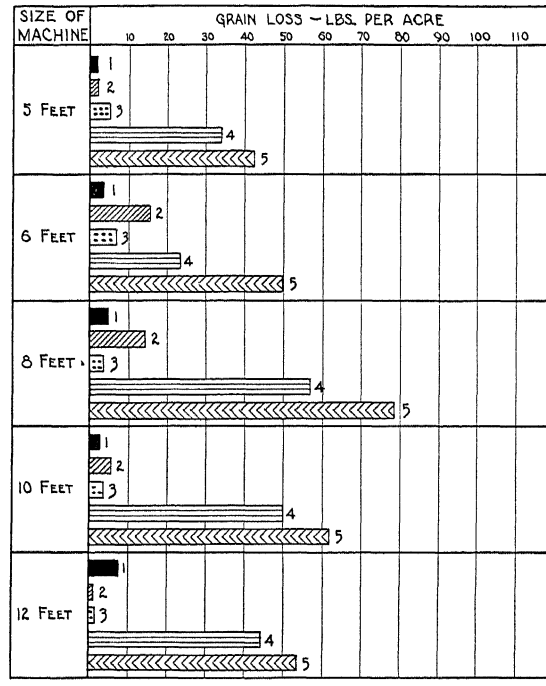


Fig. 10.—Grain losses shown by 1937 data on wheat, average of all machines

1—Cylinder loss
2—Rack loss
3—Shoe loss
4—Cutter-bar loss
5—Total loss

Machines of various sizes, ranging from 5 to 12 feet, were tested. The small 5-foot machines had as high a capacity as either the 6- or 8-foot machines. Usually, the small 5-foot machine travelled a little faster. This depended, of course, on the ground and crop conditions.

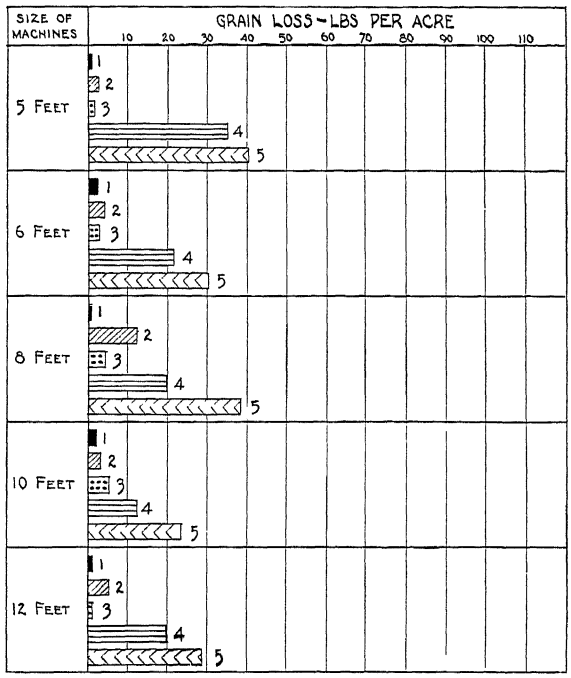


Fig. 11.—Grain losses shown by 1936 data on wheat, average of all machines

1—Cylinder loss
2—Rack loss
3—Shoe loss
4—Cutter-bar loss
5—Total loss

During the year 1936 the efficiency of combines was usually close to 100 per cent. This was true regardless of size or type of machine. In 1937 the efficiency was much lower largely because of the heavy weed growth and the failure of operators to adjust their machines to meet this condition. In a few cases a good operator was found to be operating his machine 99.5 to 99.8 per cent efficiently.

In 1936 the grain losses were small and were evenly distributed at the cylinder, rack, shoe, and cutter bar. In a few cases the shoe loss was comparatively high, but it was usually reduced by a few adjustments made on the machine.

In 1937, however, the rack and shoe of the combine were found to be wasting grain heavily. In one instance a machine was wasting grain over the rack and shoe at the rate of 381 pounds per acre. This machine was badly out of

adjustment. As in all similar tests in 1937, the cylinder loss was extremely low, and this was largely responsible for high grain losses over the straw rack and shoe.

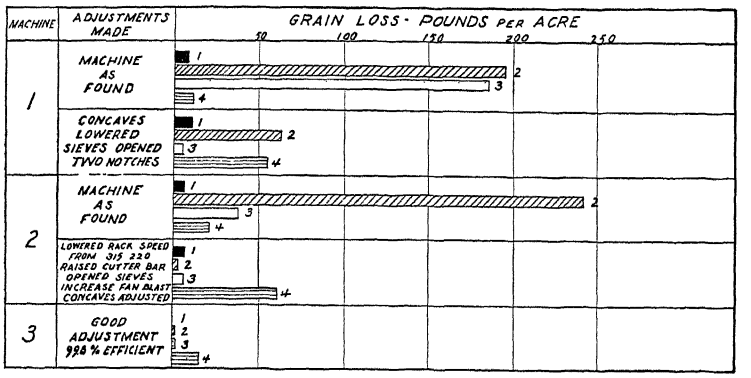


Fig. 12.—The effect of machine adjustment on grain (wheat) losses

1—Cylinder loss
2—Rack loss
3—Shoe loss
4—Cutter-bar loss

In order to reduce the total grain loss it was necessary to increase the cylinder loss. This was done by providing maximum clearance between the cylinder and concaves. Whole rows of teeth were also removed from the concaves if the cylinder was spike-toothed. This prevented breaking up the straw and green weeds, which, when broken up badly, would plug the openings in the straw racks and sieves and cause much grain to be carried over the rear of the machine. (McCuen and Silver)

HYBRID CORN AND CORN PLANTER SEED PLATE RELATIONSHIPS

During the past year, efforts have been continued to establish some means by which seedsmen and farmers might determine quickly which corn planter seed plates to use for each grade of seed at hand and for the make of planter involved.

The "volume method", suggested previously, by which the number of kernels in a small volume measure was to serve as an index, proved unsafe for general recommendation. This system is based on average graded corn and therefore fails occasionally when applied to very carefully graded seed.

As a next attempt, a large number of different makes of seed plates were calibrated for seed pit dimensions, thickness, vertical clearances, and outside diameter, and the plate beds of the respective hopper bottoms were measured for inside diameters. The plates were arranged according to seed pit dimensions within groups differentiated by plate thickness. It was hoped that this system would show consistency in the behavior of various makes of planters for any one grade of seed, and, therefore, might be used as a safe index for plate selection with any planter after the proper plate for one planter had been determined. This experimental work again emphasized the fact that very

slight changes in any one of a number of specifications may have a marked influence on accuracy of drop. The proposed scheme failed, evidently because variations in dimensions between elements within the same unit, between units of the same make, and between makes exist beyond the limits of the tolerance allowable for a safe system.

The next move was an attempt to answer the question: Are the volumes of the seed pits of corn planter plates a safe index to plate selection? Such volumes were determined for most of the plates of three popular makes of corn planters. The plates were then arranged according to seed pit volumes within groups differentiated first on the basis of general shape of seed pit. This method gave considerable promise as a practical index with plates which are not beveled, but it failed with those plates in which beveled surfaces are used to facilitate seed pit filling. Inasmuch as there seems no way quickly, practically, and accurately to determine what portion of the bevel should be included in seed pit volumes, pursuance of this particular method has been abandoned temporarily.

Since corn planters now on farms must be used for hybrid corn, attempts thus far to contribute toward a quick solution of the seed plate problem with hybrid corn have been confined to present corn planter equipment

There is evidence that not enough different seed plates are available for some planters to afford satisfactory "coverage" for hybrid corn needs. The lack of "coverage" is not limited to extremes in seed sizes, but may occur for grades commonly sold. Simply designing a large number of plates for each make of planter would complicate the problem further. Perhaps the best solution lies in improved design aimed toward greater standardization both of plates and grades of seeds. This will involve a much more fundamental approach to the problem than time has yet afforded, and it must be remembered that under the plate problem lies the question of efficiency of corn graders.

(Reed and Stringfield)

EAR CORN PRESSURE ON CRIB WALLS AND FLOORS

The cooperative study with the Bureau of Agricultural Engineering, United States Department of Agriculture, on the pressure of ear corn on crib walls and floor was continued for the 6-foot width of crib. The results checked closely with the previous ones reported in 1936.

The study is continued for 1937-1938 to determine more definitely the effect of settling and change in condition of the corn, both throughout a long storage period and for immediate weather changes. For example, the effects of air temperature and relative humidity variations even throughout 1 day on wall and floor pressures are to be determined. (Miller and Shier)

EAR CORN DRYING STUDIES

Crop storage studies involving the drying of hybrid seed corn have been carried on for about 2 years in cooperation with the Agronomy Department and farmers. The types of drying plants used in Indiana, Illinois, and Iowa, as well as in Ohio, were studied through personal inspection in 1936 and 1937. Considerable effort was expended in designing drying plants for Ohio hybrid seed corn producers.

Some detail studies as to rate of drying and amount of heat, air, and power required for drying corn were conducted at various drying plants, but especially at the drier designed and built by the Experiment Station in the Horticulture and Forestry Building at the Ohio State University. A fairly comprehensive report on the factors to consider in designing a corn drying plant as determined by these studies was published in an Agricultural Extension mimeographed publication, "Seed Corn Drying", since there was a great demand for such information. (Miller and Shier)

WHEAT STORAGE STUDIES

The study of wheat storage, carried on cooperatively with the Bureaus of Agricultural Engineering and Agricultural Economics, United States Department of Agriculture, was continued in 1937 as planned. The 1937 work has not been summarized and reported. The 1936 studies showed a low moisture content of grain because of the unusually dry season; consequently, no grain went out of condition in storage. The 1937 season offered more grain of high moisture content and should give some data of value in establishing limits in quality and condition of grain that may be permitted in farm storage bins. (Miller and Shier)

TOMATO IMPROVEMENT

The Departments of Agricultural Engineering, Horticulture, and Botany and Plant Pathology are cooperating in this tomato improvement project. The Department of Agricultural Engineering is studying the possibilities of the production of sturdy, disease-free tomato plants with the aid of electricity for sterilizing soil and for heating the soil and air in the plant beds.

For the soil sterilization work a resistance-type sterilizer was used. In this type of sterilizer the electricity is passed through the soil itself, and the resistance of the soil to the flow of electricity generates the heat for sterilization. The type of soil, soil moisture, and soluble salts in the soil influence the conductivity of the soil, which in turn affects the sterilizing time for different temperatures. Sterilizing temperatures ranged from 120° to 210° F. In three series of tests, there were no infestation of nematodes when the temperature of the soil was raised to 160° F. and no Fusarium wilt above a temperature of 170° F. In two of the series the control temperatures were 130° F. and 150° F., respectively, for nematodes and Fusarium wilt.

The resistance-type sterilizer, if properly and carefully operated, gives very uniform temperature throughout the soil mass, and that is necessary for satisfactory sterilization.

Soil heating cable has been used satisfactorily for a number of years for supplying heat for hotbeds. In this project an attempt was made to produce tomato plants free from Alternaria and Septoria by keeping the foliage dry with electric heat. Both soil heating cable laid on the surface and a fan-type room heater were used. The soil heating cable gave much better results than the heater. Disease-free plants were produced with the soil heating cable. Infestation, however, occurred in the field on all groups of plants. (Blauser)

DISTRICT AND COUNTY EXPERIMENT FARMS

A tabulation of activities on the District and County Experiment Farms (Table 60) shows that on 12 such farms in 1937 a total of nearly 5,000 plots contributed to the year's research findings on a number of projects. These plots varied in size from a few acres in the pasture test at the Miami County Experiment Farm to single clumps of timothy in projects designed to find the heading and blossoming dates of early, medium, and late timothy strains at different locations in the State.

Hybrid corn easily led in number of plots. This is readily justified by the great interest of Ohio farmers in this project. Hybrid corn development is still in the stage which requires widespread testing to determine for each section the best adapted hybrids out of the large number of combinations that can be put together. Doubtless this need will continue for several years.

Variety testing of wheat and oats is many years older than that of hybrid corn and already has resulted in a large substitution of such varieties as Fulhio, Trumbull, and Gladden for many of the inferior varieties formerly grown in the State. The list of very acceptable varieties now includes Thorne, and the testing blocks on the outlying farms contain these better varieties, together with new ones that the cereal breeders at the Station believe stand a chance of eventually being equal to or superior to the good varieties which have resulted from the past half century of Experiment Station work.

The work with timothy and with alfalfa-grass combinations is indicative of the assistance given by the outlying farms in solving present-day problems. A number of factors combine to make this a timely research. First, the requirements of proper soil conservation methods make it necessary in many sections to keep meadows down for more than 1 year. Second, early cut grasses make acceptable hay. Third, alfalfa and grass combinations on well-limed land sometimes make almost unbelievably large yields of hay where alfalfa alone would be a very doubtful crop. So far, timothy has been used almost entirely as the companion grass for alfalfa. It has proved excellent at the Trumbull County Experiment Farm in northeastern Ohio and satisfactory for a year or two in southern Ohio. In this latter section ordinary timothy fails to survive over a much longer period if the combination is cut early in June and the alfalfa makes a thick, highly competitive summer growth. Plots at the Hamilton, Clermont, and Washington County Experiment Farms are designed to furnish information concerning the effect on yield and stand of cutting timothy at various dates in southern Ohio. A record of heading and blossoming dates indicates that timothy requires a larger number of growing days to reach a given degree of maturity in southern Ohio than it does in the northern part of the State. Ordinary timothy scarcely starts to head in southern Ohio before early June, and by this time it is considered good practice to start cutting alfalfa. Thus, if the alfalfa-timothy combination is cut when the alfalfa is ready, the timothy is in a very immature stage. In some cases distinct injury has been noticed when timothy was cut at these southern farms as early as June 3.

Tests at the Trumbull and Belmont County Experiment Farms have shown the feasibility of growing more hay and less corn in the interests of sound soil conservation practices. The Jersey herd at the Belmont Farm from June 1,

TABLE 60.—Summary of Work at 12 District and County Experiment Farms in 1937

Kind of project	Belmont	Clermont	Hamilton	Madison	Mahoning	Miami	Paulding	Trumbull	Washington	S. E. Exp't	S. W. Exp't	N. E. Exp't	Total
Number of plots per project													
Soil fertility tests	30	88	78	87	48	60	25	82	60	80	158	.....	796
Hybrid corn (grain)	125	125	125	.....	.....	500	125	300	.....	125	358	.....	1783
Hybrid corn (silage)	.....	.....	.....	80	75	.....	.....	.....	.....	.....	.....	.....	155
Variety oats	.....	.....	.....	20	20	20	30	20	.....	100	150	.....	360
Variety wheat	27	27	27	27	27	123	30	27	.....	160	155	.....	630
Soybeans	3	3	.....	.....	.....	.....	3	.....	.....	.....	49	.....	58
Meadow mixtures and seeding	42	41	31	37	22	26	20	29	20	32	28	.....	328
Timothy	5	16	21	.....	8	5	.....	8	43	21	.....	.....	127
Red clover strains	.....	10	10	.....	.....	.....	.....	.....	.....	10	.....	.....	30
Rotations and soil condition	.....	.....	46	.....	28	8	63	32	.....	12	16	.....	205
Pastures	10	6	6	.....	32	12	.....	14	.....	45	26	.....	151
Orchards	38	12	14	.....	18	4	.....	.....	.....	.....	.....	12	98
Miscellaneous	5	4	6	.....	12	7	3	8	3	4	10	.....	62
Cooperators in non-crop projects													
Daily weather reports	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Walnut culture	.....	.....	.....	.....	Yes	.....	.....	.....	.....	.....	.....	.....	
May beetle survey	.....	.....	Yes	.....	Yes	.....	.....	.....	.....	.....	.....	.....	
Dairying	Yes	.....	.....	.....	.....	.....	.....	Yes	.....	.....	.....	.....	
Sheep	.....	.....	.....	.....	.....	.....	.....	.....	.....	Yes	.....	.....	
Poultry	.....	Yes	.....	.....	Yes	Yes	.....	.....	.....	.....	.....	.....	
Hog breeding and feeding	.....	.....	.....	Yes	.....	Yes	Yes	.....	.....	.....	.....	.....	
Beef cattle	.....	.....	.....	Yes	.....	.....	.....	.....	.....	.....	.....	.....	
Farm and livestock data													
Total acres in farm	169	130	223	166	287	123	92	154	173	300	53	125	1995
Acres tilled	70	75	85	150	92	80	75	80	45	90	42	80	964
Acres in orchards	25	12	17	.....	36	7	5	.....	28	.....	.....	6	136
Numbers of livestock	20*	60† 250‡	30*	50§ 60‖	28§	100‖	80‖	28*	80†	225† 17§	.....	600‡	.....
Miscellaneous													
Visitors during year	1400	725	870	600	1640	1890	710	2060	880	1070	350	225	12,420

*Dairy cows. †Sheep. ‡Poultry. §Beef cattle. ‖Hogs.

1936, to May 31, 1937, had an average production of 7520 pounds of milk and 395 pounds of butterfat. Roughage came entirely from pasture and hay; grain was fed at the rate of 1 pound for each 3 pounds of milk produced. At the Trumbull Farm in 1936, hay consumption per cow per day was approximately twice and silage consumption, one-half what it was 7 years before. Grain was fed to this Holstein herd at the rate of 1 pound for every 4 pounds of milk instead of 1 pound per 2.9 pounds of milk as in the earlier period. Average production for 15 cows was 11,400 pounds of milk and 389 pounds of butterfat. Approximately one-half of the tillable area was in meadows, and the aftermath from these was utilized as pasture during the July-August-September period; whereas 7 years before with meadows of a single year's duration the summer pasture shortage was met by the use of corn silage.

At the Paulding County Experiment Farm in northwestern Ohio where two decades of fertility tests have failed to show any consistent increases (except with sugar beets) from fertilizer treatments on this peculiar soil type, the trend of investigation now is toward the effect of various rotations and treatments on the physical condition of this soil and its maintenance of organic matter. The regular omission of clover in a fertilized cereal rotation has resulted in a serious decline in crop yields, but the omission of fertilizer in a grain-legume rotation has caused little if any decrease. Sugar beets have shown some increase from fertilizer treatments, but the use of suitable rotations offers equal or better prospects for permanent, profitable sugar beet production.

Since the organization of the outlying farms 20 to 25 years ago, the orchards on them have had some part in adding to the information regarding the general advantages of sods over annual cover or so-called improvement crops, also to that regarding the nitrogen requirements of bearing apple trees. With a general acceptance of the necessity of nitrogen and the superiority of sods from the standpoint of soil building, current orchard projects are designed to help solve present-day problems of maintaining good sods and growing mulch material in bearing orchards.

At various times in recent years there has been some agitation for the Experiment Station to do something with walnut culture. A start was made during the past year at the Mahoning County Experiment Farm. Plantings were of black walnuts and some of the hardy strains of English walnuts.

Considerable work is carried out in connection with livestock and poultry problems. Day-old chicks incubated by the Poultry Department from eggs produced at the Experiment Station are shipped to the Miami, Clermont, and Mahoning County Experiment Farms where they are reared. Part of the grown pullets are shipped back to the Station for comparison with those grown at the poultry plant, where conditions are more or less typical of many big poultry farms. This is part of a study of the causes of and remedies for the high mortality that far too often occurs in commercial and farm poultry flocks.

Steer feeding problems receive attention at the Madison County Experiment Farm where each year the Department of Animal Industry supervises one or more tests. There are facilities for four lots of 15 or 16 cattle each. A study of the amount of beef produced per acre has been the underlying principle in tests on this farm. A large amount of information has been obtained regarding corn silage, which several tests have shown to be a highly efficient form for utilizing the crop.

At the Miami, Paulding, and Madison County Experiment Farms the brood sows with their two litters per year are being utilized in a comparison of purebred versus crossbred hogs. Durocs, Hampshires, and Polands are the breeds involved. The project has not continued sufficiently long to permit a definite report. So far, crossbreeding even to the extent of using crossbred sows for mothers has been somewhat superior. It must be remembered, however, that good purebred males were used in all cases.

Sheep work at the Southeastern Experiment Farm is part of a four-phase project on sheep parasites. The phase under study at this Farm concerns the control of sheep parasites by special management in raising lambs and in rotation of pastures. It is supplemental to parasite treatment studies under way at Wooster.

These 12 outlying experiment farms total approximately 2,000 acres, of which nearly one-half are tillable. Orchards take up 138 acres. Livestock total 78 dairy cattle, 95 beef cattle, 365 sheep, 240 hogs, and 850 hens. Over 12,000 persons visited these Farms last year, either in organized groups or singly. The number varies from year to year but remains consistently high and is evidence that the service of these experiment farms is appreciated. All farms keep daily weather reports, another important project. (Bachtell)

FORESTRY

Through the combined efforts of State and Federal conservation agencies the general public interest in forests and the practice of forestry has increased rapidly within the past few years.

This increase is reflected in the number of requests for tree planting stock, lectures on forestry, advice on forest problems, and in the public use of the State forests.

The burden of this increased load was not noticeable as long as the CCC camps were available, but with the steady reduction of camps since 1936, the State has been forced to absorb new expenses and take over additional work without a relative increase in funds or personnel.

During years when 13 CCC camps were in operation on the State forests, the State's expense for extinguishing forest fires reached an all-time low. The loss of eight camps through contraction of the CCC and transfer of camps to other services will be reflected in the forest fire protection budget.

The State forest land acquisition program, which has been at a standstill since 1931, was given new impetus through the operation of H. B. 571, which makes income from the sale of forest products from State lands available for land purchase.

One phase of the public use of the State forests which is particularly significant is the number of people who visit the forests for the purpose of studying the forest plantations and other cultural experiments. The Waterloo Forest, which offers no scenic attractions, has some of the oldest plantations to be found on State forest land. This Forest attracted over 11,000 visitors during the calendar year 1936. It is visited by groups led by county agents or others who wish to demonstrate the results that may be achieved by forest planting. (Alderman)

THE STATE FORESTS

Acquisition.—On nearly all the State forests there are a great many interior private holdings which were not purchasable before 1930. When these tracts are no longer the homes of the owners, they are very soon found by squatters who build a home from the timber on the tract, and if not evicted soon become permanent and usually undesirable members of the community.

The livelihood of these tenants is frequently derived from the harvesting of their host's timber. After the exhaustion of this, operations are transferred to adjacent State-owned forest.

The acquisition of forest land has been confined to these areas, the purchase of which would remove the hazards of fire and timber theft or otherwise lessen the administrative cost of the forest.

The average cost of this land was slightly under $7.00 per acre. In nearly every case the boundary of the forest was shortened, for many tracts were entirely surrounded by State land.

It would be very definitely to the benefit of the State if some arrangement could be made whereby tax-delinquent land could be acquired as State forests.

Improvements.—Ranger stations consisting of a dwelling, barn, and combination shop and garage have been completed on the Dean and Pike Forests. These will be occupied in the fall of 1937.

TABLE 61.—Land Acquired and Optioned During Year

State Forest	Number of tracts acquired	Number of acres	Number of tracts optioned	Number of acres	Total number of acres
Waterloo					
Dean			1	100.00	100.00
John Bryan*					180.62
Mohican			1	143.46	143.46
Nelson Ledges					
Findley†					176.34
Scioto Trail	4	378.00	2	331.80	709.80
Shawnee	2	176.07	10	2570.15	2746.22
Zaleski					
Hocking	5	136.90	2	271.18	408.08
Pike			1	50.00	50.00
Total		690.97		3466.59	4157.56

*Acquired by gift from Hugh Taylor Birch.
†Acquired by gift from Guy B. Findley.

The dwelling on the Findley Forest is being remodeled and numerous outbuildings have been removed and sold.

The new ranger dwelling on the John Bryan Park was ready for use this year.

The Pike Forest dam was nearly completed at the end of the year, as was also the dam in Caldwell Hollow on the Scioto Trail Forest.

Suitable areas on the Zaleski and Scioto Trail Forests have been kept open and leveled off for emergency airplane landing fields.

A limestone road has been constructed through the Waterloo Forest. It makes available most of the older plantations and adds greatly to the educational value of the Forest.

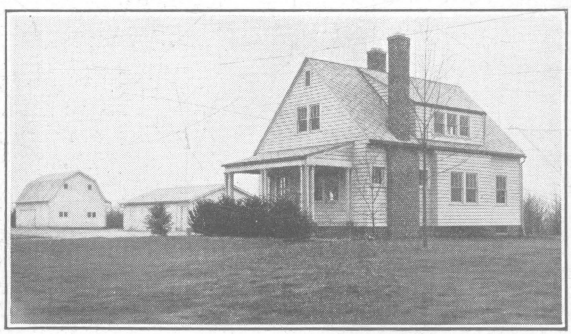


Fig. 13.—Standard ranger station, Pike State Forest

Plans are approved for the construction of a large shelter house above the dam on the Scioto Trail Forest. It will be a part of a well-developed picnic and camping area.

Two parking areas were completed on the Mohican Forest. A water system was also installed at one of the use areas, and the system of trails was greatly extended. Much was accomplished on the road connecting the north and south portions of the Forest. (Alderman)

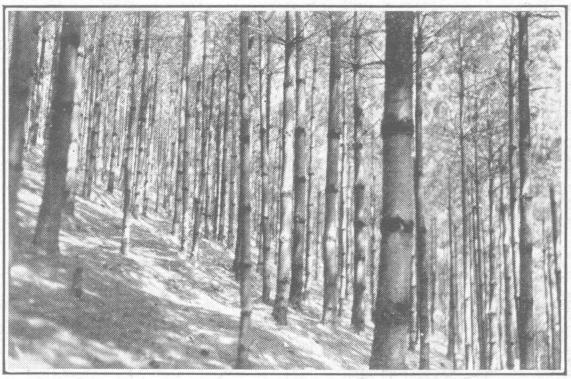


Fig. 14.—Twenty-year-old stand of white pine, Waterloo State Forest

FOREST INSECT SURVEY

In addition to the Mohican Forest experiment on the control of borers in certain species of shade trees, the study of insects found on planted stands of pine has been continued.

There has been a distinct increase in insect damage on the State forest lands in southern Ohio during the last few years, especially in pine plantings made before 1931. This damage is indicated by varying degrees of defoliation, injury to the leaders, and sometimes by the killing of large numbers of trees.

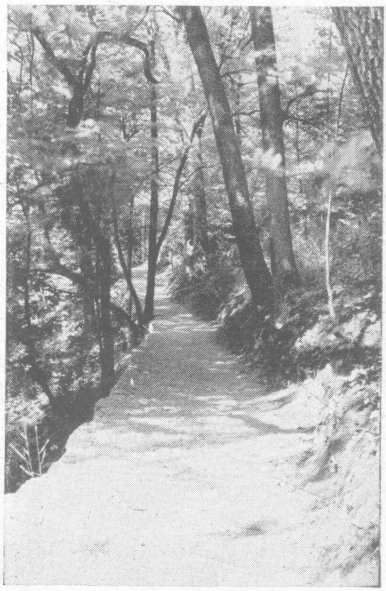


Fig. 15.—Trail along Little Miami River, John Bryan State Park

The redheaded sawfly, *Neodiprion lecontei* Fitch, is the chief cause of the defoliation which has occurred on shortleaf pine, *Pinus echinata* Mill, in practically every planting on State land. It is seldom found on any other species except in stands mixed with shortleaf pine. This insect feeds mainly on small trees; whenever large trees are attacked the feeding is confined to the tops, and this continuous feeding causes a condition which is referred to as a "stag head". In a small plot of fair-sized trees of lodgepole pine, *Pinus contorta* Doug., where this condition existed, it was found that these trees were finally attacked by bark beetles and died.

During the years of 1935 and 1936 this sawfly made its first appearance during the early part of July. In 1937 it was not found until the middle of August. It is difficult to account for this delay in appearance unless there is some correlation with the control methods

adopted in 1936 and the wet weather during the spring of 1937. This sawfly can be controlled with an arsenical spray or dust applied at the first appearance of the larvae.

The Abbott's sawfly, *Neodiprion pinetum* Nort., may become more injurious than it is now, as several small infections, scattered throughout the State, have been discovered during 1937.

The coleopteron, *Pachystethus oblivia* Horn, which feeds just above the leaf sheath on the needles and causes them to droop and eventually die, should be given more consideration in the future, since it was more numerous in 1937 than in previous years.

The double-branching and badly deformed trees are largely the result of attack on the leaders by the Nantucket tip moth, *Rhyacionia frustrana* (Comst.), the Comstock tip moth, *Rhyacionia comstockiana* Fern., and the Zimmerman pine moth, *Dioryctria zimmermani* Grt. In comparing the percentage of infestation of the pines by these insects for the past 3 years, it was found that the 1936 infestation was much less than that for 1935 and 1937. This difference can possibly be explained when the severe winter of 1935 and 1936 and the hot, dry summer of 1936 are considered. Furthermore, the parasitism of the Nantucket and Comstock tip moths ranged from 10 to 50 per cent for the remaining specimens that year.

The bark beetles, *Ips calligraphus* (Germ.), *Ips grandicollis* (Eich.), and *Dendroctonus terebrans* (Oliv.), were not as numerous in 1937 as in 1936, except in the Shawnee State Forest where there had been a deficiency of rainfall during the greater part of the summer. These insects are attracted to a very small amount of pine slash, and if slash is allowed to remain in the forest it affords ideal breeding places. If the pine slash is limited in amount, the adults will seek a new host upon emerging. These new hosts are likely to be living trees that are low in vitality. Many healthy trees are attacked by *Dendroctonus terebrans*, but not all succumb to this attack if the sap flow is great enough to drown them out, although many of these attacks leave large scars in the wood tissues long after the beetles have left. Seldom does a tree survive the attack of *Ips calligraphus*.

Two experiments have been set up for the purpose of obtaining more information regarding the behavior of the bark beetles in pine slash and in living trees; however, they have not extended over a long enough period to furnish dependable information. (Polivka)

REFORESTATION

The number of trees produced in the State nurseries and sent to planters in 1937 increased more than 13 per cent over the 1936 figure. Although this is encouraging, it does not mean that the reforestation problem in the State is being solved. In many instances land owners of moderate or limited means who should be planting trees are not or are planting too slowly. The effect is to retard the production of timber in the State.

Citizens of Ohio who purchase manufactured lumber produced in the South or West pay a freight bill on each thousand feet used that would purchase and plant enough trees to reforest an acre of land. An idle land problem and a timber shortage problem furnish convincing reasons for a state subsidy on reforestation. Only by such action can the situation be adequately met.

TABLE 62.—Trees Distributed from State Nurseries in 14 Years

Year	Number of planters	Number of trees
1924	198	190,475
1925	232	402,264
1926	374	1,532,251
1927	432	2,576,000
1928	520	3,170,430
1929	630	3,258,139
1930	937	2,643,392
1931	926	3,569,885
1932	1,013	2,569,796
1933	869	2,221,610
1934	1,048	6,836,744
1935	1,570	5,761,508
1936	1,432	6,892,712
1937	1,153	7,823,119
Total	11,334	49,448,295

TABLE 63.—Trees Distributed from State Forest Nurseries for Planting in 1937

Cooperators	Number of planters	Number of trees
Farmers	1,073	2,175,490
Municipalities	16	207,985
Institutions	6	9,000
Scouts	2	4,500
Organizations	12	29,750
Mining	2	9,000
State	23	589,079
Federal	15	4,797,700
Miscellaneous	4	615
Total	1,153	7,823,119

TABLE 64.—Species and Numbers of Trees Produced in State Nurseries in 1937

Coniferous species	Number of trees	Per cent of total	Hardwood species	Number of trees	Per cent of total
Red pine	2,484,447	32—	Black locust	859,475	11—
Scotch pine	1,771,984	23—	White ash	216,855	2+
Austrian pine	776,853	10—	Black cherry	122,600	2—
White pine	719,818	9+	Black walnut	111,030	1+
Shortleaf pine	323,159	4+	Tulip poplar	84,179	1—
Norway spruce	145,835	2—	Sugar maple	21,670	1—
Pitch pine	71,000	1—	Cottonwood	16,211	1—
Corsican pine	47,100	1—	Red mulberry	10,925	1—
Loblolly pine	14,650	1—	Silver maple	6,125	1—
Hemlock	2,713	1	Thornless honey locust	2,900	1—
Miscellaneous	10,215	1+	Scarlet oak	1,130	1—
			Red oak	1,120	1—
			Pin oak	375	1—
			Black oak	350	1—
			Black haw	150	1—
			Washington thorn	150	1—
			Swamp white oak	100	1—
Total	6,367,774	81+	Total	1,455,345	18+

(Alderman)

FOREST LAND CERTIFICATION

Table 65 shows the progress that is being made in examining and certifying to the respective county auditors, forest lands for the purpose of tax reduction. The Ohio Forest Tax Law (Sec. 5554-1-10 General Code) was put into effect in 1926, and the areas examined during the first 10 years are reported in the table as a 10-year period. The succeeding years are shown separately.

TABLE 65.—Progress in Forest Land Certification

Year	Number of areas	Acreage		Removed	
		Total	Average	Number of areas	Acres
1926-1935	628	51,400.22	81.9	4	67
1936	27	2,355.40	87.2	1	5
1937	47	1,900.57	40.5	0	0
Total	702	55,656.19	79.3	5	72

(Paton)

FOREST FIRE CONTROL

At the close of the fiscal year in June, 1937, the Division of Forestry rounded out the first 15 years of its forest fire control activities. Within this period the Division and its cooperators extinguished 4,670 individual forest fires, an average of 311 fires per year. The area protected is now a little in excess of 1,000,000 acres of woods. This figure does not include all of the lands in the State which might reasonably claim a share in this protection. The best available estimates indicate that at least an additional 1,300,000 acres of woods await protection.

Since 1930, no attempt has been made to extend the forest fire control system, as great difficulty was experienced in maintaining the work with the allotted funds in the areas already under protection. For the 5 years, 1930 to 1934 inclusive, the forest fire rate was extremely high, averaging 493 fires per year. This run of heavy fire years culminated in a total of 698 forest fires in the calendar year 1934. During the last 2 fiscal years, the occurrence rate has dropped to 207 and 267 fires per year, respectively. This is less than half the rate that prevailed during the preceding 5 years.

The fire control statistics given in last year's report and in the present one indicate that the fire control system is functioning well, and that its most important objectives are nearly within reach. These objectives are: (a) no fires over 10 acres in extent, and (b) a total burn of less than 1/10 of 1 per cent of the woodland area protected. During the fiscal year 1935-1936, the size of the average fire in terms of woods area burned was 6.8 acres; during the fiscal year 1936-1937, it was 6.6 acres. The total area burned by the 267 fires was less than 2/10 of 1 per cent of the area protected.

However, it seems unavoidable that the present standard of performance must be substantially lowered in the coming year, unless additional funds are released for fire control work. The following considerations are the grounds for this opinion. First, it is reasonable to assume that the greatly reduced rate of occurrence of fires during the last 2 fiscal years has been due principally to a temporary decrease in fire danger. Second, during the fiscal year 1936-1937,

91 per cent of the fire suppression work was done by CCC labor. Fifty per cent of the CCC camps within the Fire District have been abandoned since April, and large wooded areas are now out of reach of any camp. The State must, therefore, assume a much greater share of the cost of suppression. Third, the abandonment of two United States Forest Service camps resulted in the turning back of three towers to be manned at State expense. The State must also man the new Oreton Tower built by the McArthur Farm Security Administration Unit. Fourth, prevailing wage rates have increased, and minimum-wage legislation may necessitate an increase in compensation rates for towermen, fire wardens, and their helpers. Fifth, the area protected by the Wayne National Forest Purchase Unit in the southeastern part of the Fire District has recently been reduced to less than half its former size. This action has returned to the State protection system an area of very high risk.

Table 66 indicates that as usual April was much the worst fire month. Table 67 shows that 73 fires, 27.3 per cent of all fires, were due to carelessness and bad judgment in the burning of brush and debris; smokers caused 70 fires, or 26.2 per cent; and incendiaries, 38 fires, or 14.2 per cent. Table 68 gives more complete data by counties. Particular attention is called to the second

TABLE 66.—Forest Fires by Months, 1936-1937

Month	Fires		Area of woods burned		Damage to woods		Cost of suppression	
	Number	Per cent	Acres	Per cent	Dollars	Per cent	Dollars	Per cent
1936								
July	18	6.7	139.0	7.9	403.00	10.9	25.36	8.6
August	5	1.9	14.5	0.8	32.00	0.9	11.35	3.9
September	1	0.4	2.0	0.1	10.00	0.3	1.94	0.6
October	1	0.4	15.7	0.9	26.00	0.7	.....	.....
November	40	15.0	353.7	20.1	595.00	16.1	35.42	12.1
December	13	4.8	90.9	5.2	108.00	2.9	12.29	4.2
Six-month subtotal..	78	29.2	615.8	35.0	1174.00	31.8	86.36	27.4
1937								
January	.....	.....	.....	.....	.....	.....	.....	.....
February	2	0.7	4.5	0.3	30.00	0.8	.....	.....
March	56	21.0	235.8	13.4	478.00	12.9	37.70	12 8
April	97	36.3	709.2	40.3	1549.00	41.9	139.35	47.5
May	32	12.0	172.1	10.1	425.00	11.5	29.12	9.9
June	2	0.7	15.0	0.8	39.00	1.1	1.13	0.4
Six-month subtotal..	189	70.8	1136.6	65.0	2521.00	68.2	207.30	70.6
Total	267	100.0	1752.4	100.0	3695.00	100.0	293.66	100.0

TABLE 67.—Forest Fires by Cause, 1936-1937

Cause	Fires		Woodland area burned		Average area per fire
	Number	Per cent	Acres	Per cent	Acres
Lightning	1	0.4	.....	.....	.....
Railroad	25	9.4	87.8	5.0	3.5
Campers	10	3.8	57.4	3.3	5.7
Smokers	70	26.2	530.0	30.2	7.6
Debris burning	73	27.3	408.2	23.3	5.6
Incendiary	38	14.2	320.0	18.3	8.4
Lumbering	2	0.7	3.2	0.2	1.6
Miscellaneous	21	7.9	93.2	5.3	4.4
Unknown	27	10.1	252.6	14.4	9.4
Total	267	100.0	1752.4	100.0	6.6

column of Table 68, as it indicates the relative risk of burning in each county. The fire risk is seen to be unusually high in Lawrence, Jackson, Vinton, and Scioto Counties. Other important facts will be evident on inspection of the tables.

TABLE 68.—Forest Fire Statistics for 1936-1937, by Counties

County	Number of fires	Fires per 10,000 acres protected	Woods area burned	Size of average fire	Total protected area burned	Damage to woods	Cost to extinguish	Net area protected by State
		No.	*Acres*	*Acres*	*Pct.*	*Dol.*	*Dol.*	*Woods acres*
Adams	20	2.20	102.3	5.1	0.11	179.00	19.44	90,770
Scioto	64	3.25	583.3	9.1	0.30	1292.00	87.87	196,495
Lawrence	19	14.84	73.0	3.8	0.57	99.00	8.01	12,800
Gallia	1	1.05	3.0	3.0	0.03	6.00	2.44	9,485
Highland	0							3,200
Pike	18	1.32	63.4	3.5	0.05	114.00	17.37	135,995
Jackson	55	6.30	399.5	7.3	0.48	791.00	110.34	87,250
Ross	15	1.21	37.5	2.5	0.03	54.00	28.28	123,970
Vinton	54	4.37	353.9	6.6	0.29	843.00	11.74	123,490
Athens	0							12,090
Hocking	17	1.91	95.5	5.6	0.11	275.00	6.11	88,850
Fairfield	4	2.50	41.0	10.3	0.26	42.00	2.06	16,000
Total State area	267	2.96	1752.4	6.56	0.19	3695.00	293.66	900,395
Federal area								139,245
Total Fire District								1,039,640

(Leete)

BLISTER RUST CONTROL

During the past year the Forestry Department has cooperated with the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Plant Disease Control, and other agencies in carrying out a white pine blister rust control program in the State. This program includes a survey and mapping of white pine areas, scouting for the blister rust disease on white pine and Ribes, local control work, systematic black currant eradication, and nursery sanitation.

The work performed during 1937 is shown in Table 69.

TABLE 69.—Blister Rust Control Work in 1937

Acres of white pine mapped	3,533
Acres of control zone mapped	55,315
Acres of white pine initially protected	1,437
Number of acres worked	13,847
Number of wild Ribes destroyed	407,958
Cultivated black currants removed	
Number of locations	1,495
Number of bushes	9,714
Number of counties in which work was performed	36
Number of white pine nurseries protected	7
Number of man-months employed	1,112

A summary of the progress that has been made during the past 4 years (1933-1937) is shown in Table 70.

TABLE 70.—Blister Rust Control Progress, 1933-1937

Survey	
Acres of white pine mapped	7,660
Acreage in control zones	103,515
Local Control	
Acres of white pine protected	4,665
Acreage worked	45,117
Black Currant Eradication	
Number of counties worked	50
Number of inspections made	1,358,470
Number of locations found	7,873
Number of locations destroyed	7,672
Number of bushes found	69,433
Number of bushes destroyed	67,792

It is believed that the removal of the cultivated European black currants has assisted materially in checking the spread of the blister rust disease.

Infection was found on Ribes in Fairfield and Lorain Counties during 1937 for the first time. This extends the spread of the rust to 10 counties in Ohio.

Efforts are being made to select planting sites for white pine that are relatively free from wild Ribes in order to eliminate local control work in so far as possible. European black currant eradication work is practically completed in northeastern and southern Ohio and more attention will be given to nursery sanitation and protection of white pine plantings during the coming year.

(Dowd)

CLIMATOLOGICAL SUMMARY FOR 1936

Through January and February there was unusually cold weather. The temperature registered below zero on 12 different days and was lowest (15 degrees below) on January 23. More than 21 inches of snow fell in the 2 months.

March was noted for its many stormy days with high wind. A heavy snow of 6 inches fell on March 17. It drifted badly and blocked many roads for several days.

April was a cold, wet month with rain or snow on 23 days. There was freezing temperature on 16 days, and ice froze ½ inch thick on April 23.

The ground remained wet through the first part of May, and spring seeding and planting were delayed 2 weeks or more.

The rainfall was less than one-half the usual amount in June, and farm crops suffered from lack of moisture.

There was heavy rainfall the first and last weeks of July. The interval between was very warm and dry, and July 9 to 15 inclusive was the warmest 7-day period in the history of the Wooster records.

August was a month of high temperatures accompanied by many electrical storms which did considerable damage. Wheat, oats, and hay, however, were harvested in good condition. There have been only three August months in 49 years with a higher average temperature.

September was warm and dry.

No killing frost occurred until the last week of October.

On November 4 there was a severe snow blizzard that lasted all day. Six inches of wet snow fell during the day and night, and the temperature stayed at the freezing point. The snowfall for the month was almost 7 inches.

Five inches of snow fell in December. This raised the total for the year to 45.5 inches.

The total precipitation was 36.9 inches.

The last killing frost in the spring was April 24 and the first in autumn was October 24. There was a growing season of 183 days.

The average wind velocity was 6 miles per hour; the maximum velocity was 40 miles.

The number of days recorded as clear was 160; as cloudy, 137; with rain or snow, 136.

The records in the tables for the State were compiled from the Climatological Data, Ohio Section, published by William H. Alexander and John C. Fisher, United States Weather Bureau, Columbus, Ohio. (Patton)

TABLE 71.—Date of First and Last Killing Frost and Length of Growing Season at the Experiment Station at Wooster Each Year

Year	Date of killing frost		Length of growing season	Year	Date of killing frost		Length of growing season
	Last in spring	First in autumn	Days		Last in spring	First in autumn	Days
1894	April 13	October 7	177	1916	April 29	September 19	143
1895	May 22	September 28	129	1917	May 11	October 1	143
1896	April 24	September 24	153	1918	May 2	October 1	152
1897	May 26	September 21	118	1919	April 27	October 13	169
1898	May 9	October 16	160	1920	May 16	October 7	144
1899	May 22	September 30	131	1921	May 17	October 13	149
1900	May 10	October 18	161	1922	May 1	September 26	148
1901	May 16	October 4	141	1923	May 10	September 14	127
1902	May 10	September 14	127	1924	April 23	October 23	183
1903	May 4	October 23	172	1925	May 27	October 10	136
1904	April 20	September 22	155	1926	May 4	October 23	172
1905	May 24	October 13	142	1927	May 1	October 15	167
1906	May 10	October 11	154	1928	May 13	September 26	136
1907	May 12	October 14	155	1929	May 20	October 15	148
1908	April 17	September 30	196	1930	April 27	October 2	158
1909	May 12	October 19	160	1931	May 1	October 18	170
1910	May 15	October 29	167	1932	May 3	November 3	184
1911	May 5	October 24	172	1933	April 27	October 14	170
1912	June 8	September 30	114	1934	May 16	October 13	151
1913	June 10	September 23	105	1935	April 18	September 30	165
1914	May 2	October 27	178	1936	April 24	October 24	183
1915	May 27	October 10	136	Av.	May 9	October 8	153

TABLE 72.—Rainfall and Melted Snow in Inches at the Ohio Experiment Station, 1936

Date	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	0.10	.....	0.03	0.01	.....	.....	.....	.....	.....
2	0.02	.....	0.11	.31	0.11	.....	.....	.....	0.10	.....	0.52	0.23
3	.01	.....	.....	.04	.08	T	.50	.....	T	.....	.10	.....
4	.01	0.30	.....	.01	.....	.....	.65	0.76	.....	.....	1.22	.....
5	.01	.....	.....	.04	....	....	1.80	T	.....	.....	.20	.....
6	.10	.....	.02	.73	.....	.....	.....	.32	.....	0.87	.....	.05
7	T	.05	.10	.01	.....	.62	.....	.....	.....	.10	.....	.05
8	.02	.....	.08	T	.....	.....	.....	.....	.....	.06	T	.....
9	.09	.....	.31	.12	.....	.....	.....	.....	.....	.01	.02	.....
10	T	.....	.....	.07	.....	.....	.....	.....	.....	.75	.....	T
11	.10	.....	.01	.02	.....	.....	.....	.....	.....	.13	....	T
12	.02	.05	.21	.10	1.01	.....	.....	.....	.....	.....	.....	.....
13	.....	.67	.10	.....	.42	....	.....	.....	.07	.....	.....	.....
14	.....	.72	.23	.08	T	....	.....	T	.01	.....	.....	.....
15	.....	.02	.09	.02	.....	.05	.....	.31	.....	.....	.02	.....
16	.20	.10	T	T	.....	.....	.....	.....	.20	.06	.....	.....
17	.10	.20	.60	.01	.....	T	.....	.....	T	.23	.....	.....
18	.20	.06	.04	.03	.26	.38	.....	T	.....	.....	.....	.....
19	.15	.....	.40	.....	.41	.05	.....	.36	.....	....	....	.10
20	.05	....	.....	.....	....	.....	.....	.10	.....	.....	.....	.15
21	.....	.....	.20	.28	....	.....	.....	.19	.....	.....	....	T
22	.30	.....	.....	T	.....	.....	.....	.24	.....	.15	T	.....
23	T	.....	.93	.....	.....	.01	.14	.....	.....	.11	.....	.....
24	.....	.....	.60	.....	.24	.....	.91	.68	1.48	.....	.....	.....
25	.....	.....	.....	.....	T	.....	T	.23	.....	.....	.02	.....
26	.....	.53	.....	.....	.....	.....	.....	.33	.....	.92	T	.....
27	.....	.55	.30	.01	.....	.03	.33	.....	.....	.....	.05	.23
28	.....	.....	.....	.35	.....	.....	1.27	.14	.35	.....	T	.18
29	T	.....	.....	.05	.....	.....	.....	1.80	.43	.....	T	.06
30	.05	.....	T	.08	.....	.63	.....	.....	.02	.....	T	.09
31	.....	....	.33	.....	.....	.....	.....	.....	.....	.....	.....	.36
Total	1.43	3.25	4.66	2.46	2.53	1.80	5.61	5.46	2.66	3.39	2.15	1.50
Total for year	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36.90

TABLE 73.—Climatological Summary for Ohio and Wooster

Month	Temperature (degrees Fahrenheit)								Precipitation (inches)			Number of days				Prevailing wind direction
	Monthly mean*	Departure from normal	Highest		Lowest		Range	Greatest daily range	Average*	Departure from normal	Average snowfall	With 0.01 in. or more precipitation	Clear	Partly cloudy	Cloudy	
			°F.	Date	°F.	Date										
State																
January	22.7	−5.7	62	14	−30	24	92	52	1.65	−1.35	11.2	12	6	7	18	SW
February	22.7	−6.5	75	26	−20	1	95	50	2.55	−0.03	8.3	9	11	7	11	SW
March	43.0	+4.2	81	30	8	6	73	46	3.65	+0.27	6.3	14	10	10	11	SW
April	46.2	−3.5	85	30†	14	4	71	47	2.92	−0.19	0.9	13	6	9	15	SW
May	64.1	+3.6	97	10	29	15	68	48	1.78	−1.87	0.0	7	18	8	5	SW
June	70.3	+0.8	105	17†	37	5	68	55	1.74	−2.00	0.0	6	16	10	4	NE
July	77.0	+3.3	111	14	43	31	68	50	3.06	−0.72	0.0	6	19	8	4	NE
August	76.1	+4.5	108	21†	42	18	66	44	3.59	+0.20	0.0	11	13	12	6	SW
September	69.3	+3.6	100	14†	32	25	68	44	3.18	+0.19	0.0	8	15	8	7	SW
October	54.2	+0.8	88	6	18	28	70	46	4.00	+1.42	0.2	8	13	8	10	SW
November	37.8	−3.6	74	2	2	27	72	42	2.66	−0.08	4.5	6	11	6	13	SW
December	35.4	+3.8	68	27	− 1	1	69	43	2.31	−0.44	3.9	10	12	6	13	SW
Annual	51.6	+0.5	111	July 14	−30	Jan. 24	141	55	33.09	−4.60	35.3	110	150	99	117	SW
Wooster																
January	22.0	−5.6	48	13	−15	23	63	27	1.43	−1.70	10.5	16	3	5	23	SW
February	21.4	−6.1	57	27	−11	20	68	36	3.25	+0.81	11.0	10	12	7	10	SW
March	41.5	+3.8	74	30	13	6	61	36	4.66	+1.19	10.4	18	9	12	10	SW
April	44.1	−4.2	75	30	19	4	56	40	2.46	−0.56	1.7	20	6	1	23	SW
May	61.8	+3.2	90	10	32	15	58	39	2.53	−1.21	0.0	7	18	8	5	SW
June	68.0	+0.4	92	17	38	4†	54	46	1.80	−2.10	0.0	8	23	5	2	NE
July	73.6	+1.7	103	14	44	22	59	43	5.61	+1.53	0.0	8	27	3	1	SW
August	73.8	+4.1	96	22	47	18	49	39	5.46	+1.81	0.0	12	14	10	7	SW
September	67.5	+3.5	92	14†	40	19	52	36	2.66	−0.62	0.0	8	19	4	7	NE
October	53.1	+1.8	76	20	19	28	57	37	3.39	+0.87	0.0	11	13	3	15	SW
November	36.7	−3.8	66	3	7	27	59	34	2.15	−0.56	6.9	8	8	5	17	SW
December	35.0	+4.5	61	27	8	1	53	33	1.50	−1.17	5.0	10	8	6	17	SW
Annual	49.9	+3.3	103	July 14	−15	Jan. 23	118	46	36.90	−1.71	45.5	136	160	69	137	SW

*Based on 85 or more well-distributed stations.
†On other dates also.

TABLE 74.—Temperature and Precipitation for the State and for Wooster

Year	State					Wooster				
	Temperature			Precipitation		Temperature			Precipitation	
	Mean	Max.	Min.	Annual	Growing season*	Mean	Max.	Min.	Annual	Growing season*
1888	49.5	102	−15	39.64	24.55	47.1	92	− 5	38.05	22.76
1889	51.1	100	−14	33.41	20.32	48.7	92	− 6	39.87	24.30
1890	52.2	103	− 4	50.33	30.97	49.5	95	1	53.94	31.22
1891	51.8	101	− 5	38.61	21.73	49.8	99	0	38.48	20.76
1892	50.2	103	−27	37.16	27.26	48.1	98	−20	41.53	32.02
1893	50.0	102	−24	39.63	22.69	49.2	95	− 9	40.58	21.10
1894	52.4	105	−27	29.75	17.66	50.6	98	− 7	30.78	17.13
1895	50.0	106	−24	28.46	14.59	47.9	98	− 6	30.91	17.66
1896	51.8	102	−18	39.58	30.22	49.6	93	− 6	39.10	29.57
1897	51.5	113	−27	38.59	23.07	49.3	96	−18	36.76	21.55
1898	52.2	105	−20	43.78	26.61	50.4	96	− 9	47.85	30.77
1899	51.5	107	−39	34.32	22.18	49.5	95	−21	32.93	21.42
1900	52.2	103	−20	32.82	19.71	50.7	95	−10	36.61	23.70
1901	50.2	109	−20	32.36	23.37	48.8	95	−11	35.89	27.23
1902	50.7	100	−17	37.58	26.45	49.5	97	− 9	32.95	23.28
1903	50.5	104	−20	36.85	22.75	49.1	94	− 9	40.44	26.38
1904	48.6	99	−30	36.19	24.69	47.0	92	−21	41.28	28.16
1905	50.0	100	−22	39.08	27.20	48.9	92	−12	42.93	33.30
1906	51.6	101	−23	36.88	24.28	50.7	92	−14	42.82	30.10
1907	49.6	98	−23	42.85	28.09	48.4	90	−14	40.00	24.91
1908	52.1	104	−22	34.10	23.69	51.0	95	− 3	33.94	22.73
1909	50.9	97	−20	42.66	26.52	50.0	90	−11	44.22	28.43
1910	50.4	100	−25	36.03	19.08	49.1	94	−12	35.45	15.86
1911	52.6	107	−19	42.63	22.91	50.8	101	−11	47.15	28.28
1912	49.6	101	−37	37.82	27.85	47.8	93	−24	46.60	36.40
1913	52.3	105	−15	44.75	27.22	50.6	96	− 2	51.18	32.03
1914	50.9	106	−24	35.41	21.34	49.2	95	−18	37.38	25.11
1915	50.8	99	−22	40.83	26.56	49.0	91	−13	42.06	28.88
1916	51.0	104	−18	37.24	23.26	48.9	99	− 7	34.93	21.18
1917	47.9	103	−31	36.51	24.62	46.2	96	−19	31.86	20.56
1918	51.5	110	−28	36.54	22.84	50.5	105	−19	33.75	20.74
1919	52.3	106	−12	40.33	25.19	51.2	95	− 4	43.08	30.52
1920	50.3	98	−11	37.49	26.90	49.1	93	− 5	39.70	30.64
1921	54.6	103	2	42.97	26.80	53.3	96	9	41.90	27.85
1922	52.8	101	−20	37.04	27.13	51.4	96	−11	34.42	23.94
1923	51.4	100	− 7	39.02	25.51	50.2	97	− 1	36.30	20.73
1924	49.3	101	−20	37.34	26.48	48.1	95	−11	38.90	28.25
1925	51.4	103	−23	34.11	20.98	49.8	97	− 9	30.40	19.01
1926	50.0	103	−22	43.69	28.52	48.5	99	−11	39.42	24.35
1927	52.1	100	−17	43.01	25.86	50.7	93	− 4	43.28	24.79
1928	51.1	99	−10	34.89	22.70	50.0	93	− 5	33.46	21.48
1929	50.4	99	−25	45.83	27.70	49.4	92	−12	44.35	27.41
1930	52.5	109	−18	27.00	15.62	51.2	104	−10	28.78	16.63
1931	54.2	105	− 2	37.59	25.87	52.6	97	4	35.66	24.75
1932	52.6	104	−23	36.62	19.93	51.2	97	−10	34.57	17.70
1933	53.2	106	−17	37.39	28.05	52.0	100	− 6	33.53	24.98
1934	52.2	113	−26	26.56	20.03	50.5	99	−14	29.90	22.97
1935	51.3	106	−13	39.54	28.01	49.6	93	− 8	46.32	33.48
1936	51.6	111	−30	33.09	19.92	49.9	103	−15	36.90	25.18
Average and extremes ...	51.2	113	−39	37.67	24.19	49.7	105	−24	38.63	25.15

*March to September inclusive.

TABLE 75.—Monthly Mean Temperature at Experiment Farms and for the State

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Wooster, 1936	22.0	21.4	41.5	44.1	61.8	68.0	73.6	73.8	67.5	53.1	36.7	35.0	49.9
Average 49 years	27.6	27.5	37.7	48.3	58.6	67.6	71.9	69.7	64.0	51.9	40.5	30.5	49.7
Carpenter, 1936	23.5	25.5	44.7	47.8	63.7	70.4	75.1	74.6	68.5	53.8	38.7	36.1	51.9
Average 12 years	33.7	36.5	42.8	52.5	62.1	69.2	74.7	72.4	68.0	54.7	43.6	34.6	53.7
Germantown, 1936	23.4	25.2	46.3	47.6	65.3	72.9	81.7	79.6	70.7	55.0	38.5	36.4	53.5
Average 22 years	30.4	33.2	41.6	51.6	61.3	70.9	75.5	73.0	67.3	55.4	43.3	33.0	53.0
Strongsville, 1936	19.8	18.8	38.9	42.5	61.9	66.3	72.9	72.4	66.9	53.8*	35.6	35.6	48.8
Average 8 years (1925–1932)	29.7	33.9	39.1	49.5	60.2	68.8	74.6	72.9	67.8	55.0	43.4	32.9	52.3
Batavia, 1936	24.2	27.3	48.1	49.0	66.8	74.3	81.2	79.9	71.8	56.0	39.1	37.6	54.6
Average 21 years	32.1	34.4	43.5	52.8	62.8	71.8	76.1	73.9	68.5	56.5	44.0	34.3	54.2
Canfield, 1936	21.6	19.6	39.4	43.6	61.0	67.1	72.7	72.2	65.8	52.4	36.2	34.1	48.8
Average 20 years	26.7	28.0	37.4	46.6	57.0	66.9	70.9	68.9	63.6	51.5	40.0	30.3	49.0
Marietta, 1936	26.0	28.1	46.0	50.1	66.2	73.8	77.8	77.6	71.6	56.8	40.4	38.1	54.4
Average 21 years	32.5	34.0	43.0	52.5	62.4	71.1	75.1	73.4	67.5	55.1	43.6	34.7	53.6
Mt. Healthy, 1936	23.0	25.6	46.0	48.4	65.4	73.2	81.4	80.1	70.6	55.0	38.2	35.7	53.6
Average 21 years	31.4	33.5	42.9	52.0	61.9	71.2	75.8	73.7	68.1	55.9	43.8	33.6	53.7
Paulding, 1936	20.3	17.4	41.1	44.8	63.6	69.4	78.4	76.4	69.2	52.9	38.2	33.2	50.4
Average 21 years	25.9	27.9	37.9	48.1	59.0	69.4	74.1	71.8	65.2	52.7	40.3	29.3	50.1
Cortland, 1936	22.1	24.1	38.8	45.5	63.0	66.7	72.3	72.2	67.5	55.7	40.9	34.6	50.3
Average 16 years	27.5	29.0	37.9	48.0	58.6	68.3	72.5	69.9	65.4	52.6	40.5	31.0	50.1
London, 1936	21.2	22.1	42.9	45.4	65.2	71.6	79.8	78.0	70.4	54.4	37.4	36.4	52.1
Average 18 years	28.7	30.9	39.8	49.5	59.7	69.7	74.5	71.7	66.9	54.4	41.3	31.5	51.6
St. Clairsville, 1936	22.9	25.6	42.3	45.9	63.3	69.9	75.7	77.4	70.2	55.3	40.3	36.7	52.1
Average 12 years	31.1	32.3	39.6	49.5	62.3	72.4	76.7	72.7	68.7	54.6	42.6	33.5	53.0
Fleming, 1936	29.4	30.4	48.1	50.7	67.6	74.5	78.3	77.4	72.3	58.7	43.9	41.6	56.1
Average 16 years	36.6	37.6	45.2	54.5	63.1	71.0	75.0	73.0	69.6	58.9	47.9	39.5	56.0
Holgate, 1936	19.6	17.0	40.1	43.8	62.4	66.8	75.6	74.6	66.4	51.0	34.2	30.7	48.5
Average 7 years	28.7	28.3	36.0	47.0	59.9	70.3	75.6	71.9	65.8	52.0	39.8	29.5	50.4
State, 1936	22.7	22.7	43.0	46.2	64.1	70.3	77.0	76.1	69.3	54.2	37.8	35.4	51.6
Average 54 years	28.4	29.2	38.8	49.7	60.5	69.5	73.7	71.6	65.7	53.4	41.4	31.6	51.1

*Medina.

TABLE 76.—Monthly Rainfall at Experiment Farms and for the State

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Wooster, 1936	1.43	3.25	4.66	2.46	2.53	1.80	5.61	5.46	2.66	3.39	2.15	1.50	36.90
Average 49 years	3.13	2.44	3.47	3.02	3.74	3.90	4.08	3.65	3.28	2.52	2.71	2.67	38.63
Carpenter, 1936	2.61	2.37	4.19	4.08	1.15	1.44	1.56	4.59	1.18	5.00	3.56	3.67	35.40
Average 30 years	3.55	2.57	3.70	3.32	3.53	3.96	3.71	3.75	2.35	2.74	2.42	3.07	39.04
Germantown, 1936	1.36	2.63	2.06	3.93	1.21	0.81	0.67	3.23	3.78	4.58	2.92	2.22	29.40
Average 31 years	3.48	2.33	3.72	3.53	3.52	3.25	3.28	3 86	3.58	3.03	2.77	2.95	39.04
Strongsville, 1936	0.45	2.47	3.41	2.46	2.24	1.65	3.05	5.01	2.87	2.28*	2.77	1.53	30.19
Average 33 years	2.72	2.08	3.09	3.33	3.55	3.34	3.83	3.43	3.54	2.86	2.80	2.82	37.47
Batavia, 1936	1.06	2.51	2.91	3.49	1.52	0.99	0.66	4.32	3.94	6.38	4.20	2.51	34.49
Average 21 years	3.08	1.85	3.17	3.51	3.85	3.76	3.55	4.61	3.27	2.98	2.81	2.87	39.33
Canfield, 1936	1.49	2.50	3.37	2.14	2.67	2.06	2.49	4.51	2.68	3.28	2.77	1.78	31.74
Average 20 years	1.99	1.60	2.55	3.00	3.35	3.71	3.74	3.30	3.17	2.64	2.76	2.39	34.27
Marietta, 1936	3.30	2.29	4.97	4.03	1.28	1.82	3.42	2.36	1.49	2.36	3.64	3.58	34.54
Average 21 years	3.19	2.34	3.67	3.34	3.58	3.92	4.11	4.28	2.78	2.70	2.99	3.08	40.00
Mt. Healthy, 1936	1.17	1.47	2.87	3.25	1.96	1.05	0.70	3.00	4.97	5.54	3.75	2.96	32.69
Average 21 years	3.04	2.00	4.00	3.64	3.86	3.62	3.66	3.62	3.70	3.17	3.06	3.01	40.36
Paulding, 1936	1.34	3.19	3.36	2.37	1.95	3.10	0.98	3.54	3.76	3.17	2.71	2.62	32.09
Average 21 years	2.31	1.45	3.28	3.29	3.61	3.39	2.89	2.44	3.52	2.71	2.60	2.66	34.24
Cortland, 1936	1.56	1.70	1.48	1.77	1.53	2.23	3.07	5.97	1.88	2.87	1.62	3.43	29.11
Average 16 years	2.22	1.65	2.75	2.82	2.94	3.15	4.15	3.30	3.84	2.33	2.89	2.60	34.66
London, 1936	1.13	1.93	2.87	4.83	3.98	0.87	0.56	3.45	5.04	3.85	2.63	2.30	33.44
Average 18 years	2.57	1.82	3.35	3.59	3.70	3.23	3.50	3.78	3.14	2.65	3.17	2.82	37.33
St. Clairsville, 1936	2.79	3.25	5.76	3.15	1.60	1.35	3.68	3.10	2.53	5.00	3.69	2.65	38.55
Average 12 years	2.43	2.41	2.64	3.16	3.32	3.50	4.35	3.58	3.29	2.92	2.84	2.56	37.00
Fleming, 1936	1.67	1.05	3.42	4.07	1.29	1.71	2.45	2.43	2.26	2.85	3.39	3.59	30.18
Average 16 years	2.93	2.28	3.65	3.07	3.36	4.10	4.22	4.42	3.11	2.31	3.27	3.43	40.16
Holgate, 1936	0.91	2.74	2.90	1.69	1.86	2.54	1.89	1.64	3.91	2.81	1.23	2.12	26.24
Average 7 years	2.31	1.40	2.74	2.53	3.02	2.55	2.55	2.29	3.51	1.86	2.05	2.04	28.85
State, 1936	1.65	2.55	3.65	2.92	1.78	1.74	3.06	3.59	3.18	4.00	2.66	2.31	33.09
Average 54 years	3.00	2.58	3.38	3.11	3.65	3.74	3.78	3.39	2.99	2.58	2.74	2.75	37.69

*Medina.

REPORT OF THE BURSAR

July 1, 1936, to June 30, 1937

CONSOLIDATED STATEMENT

ASSETS AND LIABILITIES

ASSETS

Current Assets, June 30, 1937	$ 136,975.64	
Contingent Assets	21,654.78	
Land	670,634.78	
Land Improvements	68,092.81	
Buildings	668,191.68	
Departmental Equipment	494,957.73	
Total Assets		$2,060,507.42

LIABILITIES

Capital Account	$2,038,852.64	
Special State Appropriations	21,654.78	
Total Liabilities		$2,060,507.42

INCOME AND EXPENDITURES

INCOME

Cash Balance July 1, 1936	$ 123,767.60	
Appropriations by State Legislature	389,760.29	
Appropriations by U. S. Government	144,218.72	
Sale of Produce, etc.	114,466.32	
Total Income		$ 772,212.93
Less funds paid to State Treasurer and not available for use by the Station		270.37
Total Available Income		$ 771,942.56

EXPENDITURES

Salaries	$ 332,199.68	
Employees and Extra Labor	113,172.61	
Stationery and Office Supplies	2,947.93	
Incidentals	4,452.44	
Laboratory Supplies	5,807.96	
Materials and General Supplies	53,645.85	
Repairs to Equipment	8,180.28	
Telephone and Telegraph	2,324.73	
Freight, Express, and Cartage	2,939.62	
Travel	7,058.20	
Feed	41,686.27	
Fertilizers	1,404.49	
Apparatus	2,294.14	
Furniture and Fixtures	1,889.32	
Machinery, Tools, etc.	20,247.28	
Library	853.75	
Livestock	12,828.03	
Land	12,361.08	
Land Improvement	6,492.53	
Buildings	2,180.73	
Total Expenditures		$ 634,966.92
By Balance Forward		136,975.64
Total		$ 771,942.56

Respectfully Submitted,

W. H. Kramer, Bursar